THE LATE

LIEUT.-GENERAL SIR HERBERT MACPHERSON,

V.C., K.C.B., K.C.S.I.

PREFACE.

THIS Manual was begun at the instance of a former Commander-in-Chief in India, General Sir George White, G.C.B., V.C., who saw that if military farms were to be extended with proper regard to economy, the experience gained in the past must be placed within reach of the men who were to be entrusted with their development in the future.

It records the results of the labours, the experiments and the observation of the twenty-one years that have passed since General Sir Herbert Macpherson started at Allahabad the first military farm in India for the systematic cultivation of grass.

His unflagging zeal set the scheme going; and the practical lines he laid down for its working have directly led to a success that is to-day justifying the existence of numbers of similar farms all over the country.

CONTENTS.

PART I.

PART II.

LIST OF PLATES.

PART I.

Part II.

The Macpherson Lake at Allahabad. A reclaimed ravine about 500 yards in extreme width The sloping banks were

THE FARM MANUAL.

PART I.

CHAPTER I.

Soil: its Composition and Properties.

In grass-farming, as in agriculture, a thorough knowledge of the various soils which are met with in India is of the utmost importance. Without this, successful results can hardly be hoped for.

The soil and the atmosphere are the two primary sources of the food both of plants and animals: their products containing no chemical element which is not also found in the soil or the air.

Soil is that portion of surface earth above the sub-soil, in which all nutriment and plant food is deposited. It is perhaps of greatest depth in kitchen gardens, or in highly manured land; but in many places it is extremely shallow, and on uneven land it will often be observed that it has altogether been washed away by flood water—the sub-soil being left exposed. Soil defined.

The sub-soil is that portion immediately below the soil and bears relationship to the latter, inasmuch as it soon becomes soil by exposure to the air, by moisture and temperature aided by plant and animal matter. Sub-soil defined

There are various kinds of soil, with all of which the agriculturist is familiar. The colour, and to some extent, the texture are the visible differences of soils. Thus, a loose, dry, open soil, when trodden upon, gives way to the pressure; whereas a stiff, tenacious soil is firm and adheres to the foot. Sandy soil, also, will be found coarse and gritty, while in clay soil the particles will be found soapy or greasy.

Mineral and organic matters are the solid substances which compose soils. The former are derived from the decay of rocks, and the latter from that of vegetable and animal substances. Sand and clay are the predominant ingredients of soils, though some soils have too large a proportion of either one or the other. A soil composed entirely of sand would be quite worthless, because it is loose, affords no hold for roots, contains little nourishment for plants and does not retain moisture, as water sinks through it and evaporation takes place very rapidly. On the other hand, a soil composed entirely of clay is equally worthless, since water cannot permeate it but lodges on the surface where it is quickly evaporated — the surface remaining to be baked. The combination of sand and clay are requisite in farm lands, for while the former tends to make the soil light, open, and permeable to moisture, air and warmth, the latter retains moisture, gives tenacity to the soil, and enables it to absorb and retain the useful products of decomposing matters. Composition of soils.

Sandy soils therefore require to be stiffened, while clayey soils require to be loosened. This can only be done by adding clay to the sandy soil and sand to the clayey soil, or by manuring. Different kind of soil.

Soils are named according to the proportion they contain of each of these two ingredients. Any soil which does not contain at least 10 per cent. of clay is termed "sand," that which contains from 10 to 40 per cent. of clay is called "sandy loam;" while soil which contains 40 to 70 per cent. of clay is termed "loam," that containing 70 to 85 of clay, "clay loam," and that having 85 to 95 "stiff clay."

Soils are often spoken of as *sandy*, *loamy*, *or clayey*, according as they are light, open and free, or heavy and stiff.

Sources of loss and gain to soils.

A *mellow* soil is one which has been reduced either by artificial o natural means to a fine state of sub-division : a *hungry* soil is one greedy of moisture or water but with little power of retaining either ; a *cold* soil is one containing an excess of clay or *humus*.

roperties of umus.

Sandy soil requires as a manure some agent which will assist it to retain moisture, and this is best secured by the addition of *humus* or decayed vegetable or animal matter of a dark brown, or blackish colour such as is common in garden soils. This addition of *humus*, besides assisting the sandy soil to retain its moisture, enriches it. The best way of obtaining *humus* for the soil is to plough into it all useless vegetable matter or green crops, especially those of the *leguminosæ* family. For clay soils it is required to open the soil and allow water to permeate it as well as to admit air and light. For this also *humus* is useful.

CHAPTER II.

Sources of Loss and Gain to Soils.

ources of loss o soils.

Soils are ever changing, for they are continually giving up exhausted and receiving fresh matter. Plants growing in the soil rob it of a portion of its moisture and other ingredients. This has been proved by analysing the residue of burnt plants which is found to contain mineral matters existing in the soil but not in the air. Loss of water and moisture is caused by direct evaporation from the surface into the air, and also by the plant, which absorbs the moisture through its roots and gives it off into the air through its leaves.

A further loss to the soil is caused by drainage water, which dissolves a portion of the soluble substances of the soil and washes it away together with particles of soil and earth, leaving the sub-soil exposed. Heavy and continuous rain also causes a loss if it is allowed to flow off and carry with it the valuable soluble matters contained in the soil. It has also been proved by experiment that soil is composed of both soluble and insoluble substances.

ources of gain o soils.

Soil is benefited by exposure to the atmosphere, by temperature, by the residue of crops, and by the application of manures or other dressings, etc. By exposure to the air and sun, sub-soil gradually becomes soil. Every change of temperature affects the soil beneficially. Rain supplies water and certain ingredients which improve the soil. The residue of plants, chiefly roots, which constitute the main source of *humus*, are also beneficial. Manures and artificial fertilisers likewise assist.

low to regulate noisture in the oil.

Soils suffer just as much from excess of moisture as from too little. The requisite amount of moisture can be regulated by drainage and tillage. Land which lies fallow gives off less moisture than that on which crops are cultivated ; this is specially the case with root crops which draw more moisture from the soil than other crops, and in consequence give off more moisture through their leaves. The water thus given off through the leaves is pure, and the evaporation in this respect, especially in root crops, is sometimes greater than the supply from the reserves in the soil below. This will be observed by examining the leaves of a crop at midday, when the sun is most powerful. The leaves then appear drooping, but as night approaches there is less evaporation, as the supply of water then becomes equal to the demand on it. The maintenance of a suitable degree of moisture depends chiefly on the physical condition of the soil and its capillarity. The power of capillary attraction depends on the delicacy of the tubes, of which there are myriads in the soil; that is to say, the finer the soil, the finer and more delicate and efficient are the tubes, and the more perfect the power of capillary attraction ; and, conversely, the more open the tubes, the smaller the power. As an instance of capillary attraction, note how a lump of sugar put into coffee becomes soaked to the top with the coffee. Similarly, a sponge absorbs water, and blotting paper a drop of ink. When soil is coarse the more delicate tubes give place to wider ones. Sometimes a soil is to all appearances devoid of moisture, but dig down into the ground and you will find that near the surface the soil is hard and dry, while the deeper you dig until you arrive at the water level the moister the earth becomes. The chief reason why the soil is dry in this case is defective capillary attraction which does not permit the moisture to rise from below to meet the loss by evaporation on the surface

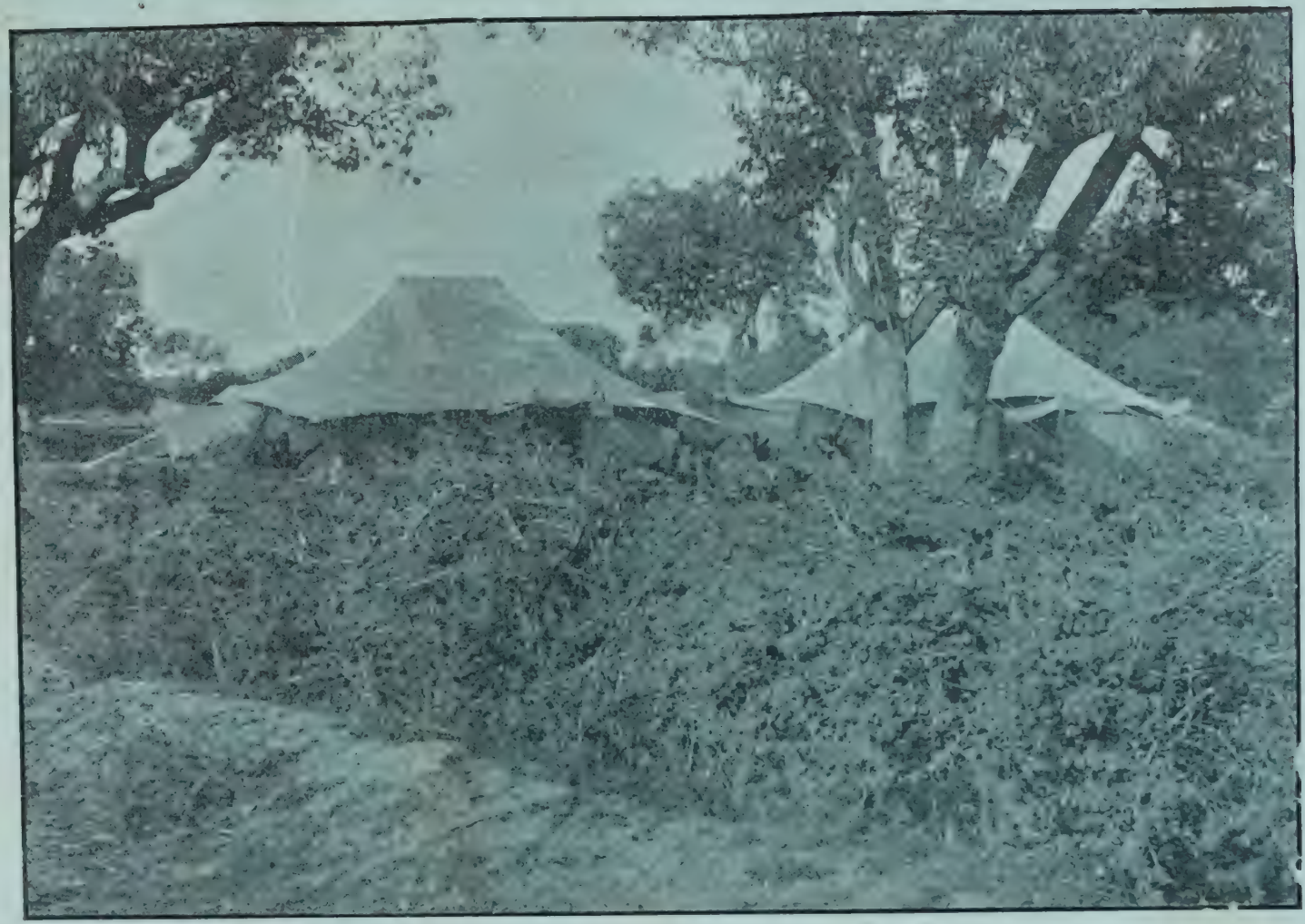


Photo-Block. alcutta, 1902

Showing *babúl* fence of 3 years' growth, in front of tents.

That is to say, the capillary tubes have become too broad for the water to travel along, and are unable to draw the supply of moisture from below. It is very essential that any one undertaking grass farming, or indeed any farming, should thoroughly understand this physical action. Rain provides moisture to replenish the stores below the surface, and the moisture passes upwards in the dry season to replace that drawn off by evaporation. This moisture tends to dissolve and keep the soluble food for the plants about their roots in the moist state, in which alone the plants can take it up. If it is desired to prevent excessive evaporation, you must break up and pulverise the surface of the soil or afford it shelter by laying on a layer of leaves or any kind of refuse.

Sometimes, owing to ploughing having always been done at one depth, a hard cake of clay forms below and interrupts the capillarity of the soil. In such cases it is necessary to break up and expose the hard cake, which is called a *plough-pan*, to the atmosphere, and allow the moisture to circulate up through it.

Defective capillarity.

CHAPTER III.

The Selection of Grass Lands.

An officer entrusted with the selection of lands for farming purposes, should be thoroughly acquainted with the elements of agriculture, in order to enable him to select the lands best suited for grass farming. A loam soil is the best suited for the purpose, that is to say, a soil which is not too loose nor yet too stiff. A stiff clay soil can readily be ascertained by walking over it. When moist it will adhere to the foot, whereas a loose soil will give under the feet like sand. It is a delusion to suppose that arable lands are the best for grass cultivation. The soil may be much richer than grazing land, but the latter is nevertheless the better for grass. The reason of this is, that the cultivated or crop land has been under crops probably for years, and the grass naturally growing on it has been treated as a weed and continually uprooted as it appeared above ground. On the other hand the roots of the grass are existent in the grazing land, which being constantly grazed has benefited greatly from the droppings of the cattle, etc. Another point worthy of notice is that grass will not be obtained off arable land in any quantity under two years; while grazing land if properly preserved will yield a good crop even in one year. Although it would be remunerative to take up the very best and most expensive lands for grass, yet, at the same time, economy should be studied, and, if a better outturn is obtained off grazing than off arable land, it is obviously the best policy to take up grazing lands in preference, especially in consideration of the very great difference in the corresponding rents. If sufficient grazing land is not available, then arable land must be rented. The appropriation of sandy soil for grass farms is to be deprecated, even though it be obtained rent free. Only coarse grasses such as *khusa*, *kansa* and *sărpăt*, will grow on it, and then only when the bottom is clay. Instances have occurred where much money has been thrown away in attempting to reclaim such lands. This reclamation costs more than the results justify.

Grazing land preferable to arable land.

A sandy soil unsuitable.

A stiff clay soil, though not so suitable as a loam one, can be more easily and conveniently converted into grass lands than the sandy soil above alluded to. The grazing grounds in cantonments, owing to having been grazed from time immemorial without being improved, are almost barren, with only a blade of grass growing here and there. It is wonderful with what a small amount of care and protection such lands can be made to produce heavy and luxuriant crops of grass. Still clayey soil should not therefore be despised on account of its barren appearance. Numerous failures in grass farming can be traced to a bad selection of land. Every farmer should be able to decide what land is best suited for pasture, meadow, or crops respectively.

When starting a grass farm it is generally considered more expedient to experiment with a small area at first, and to gradually develop year by year. This idea is entirely erroneous, as the success of grass farming has been proved by experiment to be an absolute certainty. It is advisable to take up sufficient land to meet all requirements

Gradual development of farm not advisable.

at once, as the land cannot be expected to yield a remunerative outturn under two years' preservation. Adding to the area by bits only retards the development of the farm for several years. Another drawback to this experimental system is the matter of expense, as the smaller the farm the greater proportionately is the cost of the supervising establishment, etc. The above conclusively shows that it is more desirable and convenient to have a surplus rather than an insufficient area, in consideration of the length of time it takes to establish grass preserves. Any surplus fodder can always be profitably disposed of.

termine the quisite area of ass farms.

In order to arrive at the requisite area for a farm in cantonments, it is necessary to ascertain the requirements in green grass of all the animals in the station including cavalry and artillery horses, grass-cutters' ponies, mules, bullocks, dairy and slaughter cattle, etc. Add to this 20 per cent. for loss in converting green grass into hay and silage, and divide the total quantity in maunds by 60, which is the approximate outturn of grass per acre expected for the first two years without manuring.

he selection of nd within ntonment nits desirable.

Land should be selected in cantonments as near as possible to the animals which have to be fed, even though the rent to be paid is higher than for rukh lands distant from the station. This is considered expedient, more especially for the following reasons: the easier supervision of the farms; the saving of expenditure in the carriage of fodder; greater facility in manuring and general improvements; and in the case of the cavalry, the grass-cutters and ponies can be more profitably and conveniently utilized than at a distance from their lines. It is only in cases of emergency or scarcity of grass, that lands should be rented at any distance from cantonments, as in such cases it is difficult to cultivate the grass. The land leased should be closely situated to the railway, to save expense in transit. At some stations it is profitable for the first few years to lease the sides of the railway embankments and enclosures, the rent being usually very small in comparison with the yield of grass obtained.

rass cultiva- on on railway nbankments.

rass cultiva- on on encamp- g grounds.

All encamping grounds in each District should be reserved for the provision of fodder for all Government animals accompanying troops on the line of march. The rental of these is usually favourable, and, as they comprise principally grazing land, good grass crops can be obtained and stored for time of necessity. This arrangement, besides being fully appreciated by the ryot in having saved him from the depredations of the cavalry grass-cutters, obviates the risk of feeding horses on contaminated fodder. The Civil Authorities, by requisition, provide grass at all encamping grounds and this grass is cut from land previously grazed by village cattle amongst which some disease is almost always certain to exist.

CHAPTER IV.

The Protection of Grass Lands.

he protection grass lands.

The foregoing chapters contain sufficient information regarding the rudiments of agriculture to enable the beginner to make a start: it now remains to show how this information can be applied. The first precaution necessary in grass-farming is the protection of the grass lands from trespass by men and specially by cattle. Although it is expedient to adopt the best and safest means for enclosing the lands, still, at the same time these should not be expensive. Many failures and much waste of money may be traced to inexperience in this matter when first starting a grass farm. The nature of the fence required depends upon the circumstances of the case. If villages in which cattle are plentiful, border on farm lands, a more expensive and substantial fence will be necessary, than would be needed on lands less exposed to trespass. On farms distant from towns and villages, protection by rangers would be sufficient. It would obviously be impolitic to spend large sums on barbed wire or on ditches and embankments in cases where mere protection would be sufficient. Barbed wire fencing is only necessary where cattle trespass and grazing cannot be otherwise guarded against. Ditches and embankments are mere waste of money, for they do not keep cattle out and only act as a boundary mark. If a strong and durable fence is necessary, the cheapest and most efficacious for India is a *babúl* fence. It should be remembered, however, that land which is required for the manœuvring of troops cannot be enclosed by any effective fence. A barbed wire fence is also objectionable, owing to the risk

arbed wire ncing and itches.

Photo-Block. Survey of India Offices, Calcutta, 1902.

Showing *gáthá-bandi* on reclaimed land with *shisham* and *babúl* plantations. The plate shows the *gáthas* very indistinctly: the dark lines running parallel to each other are the fences.

run by cavalry and artillery horses coming into contact with it. Natives also steal the iron standards.

A *babúl* fence is grown from seed collected in April and May. The quickest seed for germinating is that thrown out by goats when chewing the cud. All that is necessary is to dig up the soil and make a small trench about 1½ to 2 inches deep to receive the seed. This should be sown in a single row, two inches apart, to obviate the risk of seeds not germinating. No irrigation is required; but when the seedlings are three years old, they should be lopped and turned down. If the fence is required to prevent trespass by men as well as by cattle, then plough up a strip of land, say 10 feet wide, sow the *babúl* seed broadcast, and then harrow lightly. The latter is a very impervious fence. (See plate No. 1.) *Babúl* fence.

In most cases, however, the provision of any kind of fence is waste of money, as the majority of the cattle illicitly grazed on grass farm lands, are owned by people living in the vicinity of cantonments and consequently within the area enclosed. Cases have frequently occurred where, for the sake of facility of manœuvring troops, gaps have had to be cut in the fence, thus rendering it useless. The cost of repairing and trimming these hedges is a very heavy item. Fencing interferes with the manœuvering troops.

The provision of a fence will not obviate the necessity for maintaining rangers, whose duties in connection with prevention of grass thefts and protection of hay stacks, etc., demand their continuous employment. It should be a general and fast rule that, unless the circumstances of the case demand otherwise, all grass lands should be protected only by rangers. Rangers necessary.

The number of rangers necessary will depend on the situation of the lands, the area of the plots and the extent of the village population adjoining the land. About one man to 100 acres is the utmost required in a large and populous cantonment ; while for large open rukhs, distant from cantonments and in a ring fence, one man to 200 acres will be found sufficient. It is advantageous to apportion the land into areas varying from 400 to 600 acres, each under a head ranger with several assistant rangers under him.

CHAPTER V.

The Improvement of Grass Lands.

Assuming that the land is taken up from 1st July, the commencement of the agricultural year, it will not be possible to execute any other improvements beyond defining boundaries and constructing enclosures. In the case of fallow or grazing land, shallow ploughing both ways, with country ploughs, is sufficient to open up the earth for the admission of air and water. This ploughing should be done as soon as possible after the first fall of rain, in order to render it beneficial to the first crop. If the ploughing is done later in the rains, the tendency will be to destroy many of the rain grasses, and the outturn will not be so favourable in quantity and weight. If manure is available and time admits, a top-dressing might be applied after the ploughing ; but, beyond this, no further expense need be incurred on grazing lands during the first year. The roots of the indigenous grasses being in the ground, no grass seed should be sown, strict conservation being sufficient. Instances have been known where heavy expenditure has been incurred on this account with complete failure. Improvements to grazing land

Arable land should be treated very differently from grazing land. When appropriated for grass cultivation, arable land needs no ploughing, it having continually been ploughed during past years ; but it should be manured, otherwise very little grass can be expected during the first year owing to constant weeding, while the land was under crops. Improvements to arable land.

It is advisable to commence manuring the land as soon as it has been leased ; and, although it will not be possible to reap the full benefit of the manuring in the first year, a considerably increased outturn may be expected.

During the initial stage of the farm, no financial profit must be looked for as all available funds should be invested in developing the farm by improvements. Provided Savings to be invested in developing farms.

these improvements are judiciously carried out, as in any other commercial concerns of the kind, success is inevitable.

provements ned.

The following are the more important methods for improving grass lands :—

1. *Gáthá bănding.*
2. Ravine silting and *bănding.*
3. Drainage.
4. Road-making.
5. Well sinking.
6. Levelling.
7. Erection of Buildings.
8. Arboriculture.
9. Tillage.
10. Irrigation.
11. Reclamation of barren or *úsar* land.
12. Weeding.
13. Manuring.

CHAPTER VI.

Gáthá bănding, Ravine Silting and Drainage.

thá banding.

Gáthá bănding is the system of dividing the land into plots by means of earthen banks. (See plates Nos. 2 and 11.) The object of this *bănding* is to divide the land into suitable areas for purposes of mapping, etc., and it is especially useful in reclaiming and draining land, as explained further on. When about to *bănd* the land, the following points should be observed :—(1) The slope of the land, and (2) the general direction of the water courses.

e of plots.

On level land the plots should be larger than on sloping ground and should vary from 2 to 4 acres. On sloping land, the size of plots should vary from ¼ acre to 1 acre according to the steepness of the slope. The steeper the slope the smaller the plot. The banks should run across at right angles to the waterflow so as to dam the flood; and, as far as possible, the plots should be rectangular or square. To resist the force of the stream in rainy weather, the bank which runs across the flow of water should be much higher and stronger than fences parallel to it. The other fences may be smaller. The fences should be straight and not zigzag. They are made by throwing up the earth from both sides for the large *bănd* and from one side only for the smaller *bănd.*

ject of *gáthá nding.*

The excavation is done at the rate of about 1 rupee per thousand cubic feet in dry weather, and at about 12 annas in the rains when the soil is moist. The object is (1) to prevent loss of soil in the rains, for on sloping land without *gáthá bănding* the loose soil after ploughing would wash away, leaving the sub-soil exposed; (2) to keep the land moist by preventing water draining off; and (3) to retain the valuable chemical elements contained in rain water. On level land the *gáthá bándies* which are further apart are useful in preventing the wash of the soluble matter of the soil.

The height of the embankments will depend on the flow of water to be dammed, and, in case of an excessive accumulation of water, it should be allowed to escape through an outlet in the lower fence near the top, so that the soluble parts of the soil held in solution may be allowed to subside on the lowest part of the plot, while the extra water only is allowed to escape. If it is desired to retain all the rain water, about the close of the monsoon when such a course is feasible, all that is necessary is to close the aperture in the *bănd.* This specially applies to sloping land. On level land it is not desirable to allow any excessive accumulation of water, as it would rot the grasses, encourage the growth of weeds and coarse grasses and generally result in the deterioration of the land. It is therefore advisable, in the case of excessive accumulations of water, to provide apertures for its escape.

With the aid of *gáthá bănding*, sloping land gradually becomes levelled in the course of a few years by the process of silting; and, by the same process, broken ravine ground is converted into undulating meadow land. Without *gáthá bănding* it is impossible to satisfactorily reclaim land. Land thus treated in the Allahabad District at an expenditure of some Rs. 5 an acre, has been found to repay the expenditure incurred on it within two years. Castor oil seed should be sown on the embankments of the *gáthá bándies* in order to recoup the expenditure.

Photo-Block.

A portion of the main bund of the Macpherson Lake at Allahabad. Total length about 700 yards. There is a weir at either end; one with wire netting to prevent fish from escaping is shown above water level, to the right. The lake water can be either used for irrigation or drained off and the bed of the lake cultivated. The bund is made entirely of clay.

Gátha bănding, ravine silting and drainage.

Ravines.

In most cantonments in India, large areas of land are rendered valueless owing to their being intersected by large ravines which during the rains carry off the drainage of the surrounding country into rivers, tanks, etc. Every rainy season leaves these ravines wider, owing to the flood water cutting away their banks and bottoms, and being also very steep, they detract from the appearance of the cantonment, and usually become the common latrine of the neighbourhood. The areas comprising ravines are the worst to reclaim ; nevertheless they can be made to yield a respectable profit. (See frontispiece.) The beginner would probably set to work in silting the ravines by sloping their sides and throwing in loose earth. The result of this would be that the whole of the loose earth thrown into the ravine would be washed away during the first flood, and the ravines would become wider than they originally were.

How to proceed in *bănding*.

The following process has been found to answer well. The ravine should be *bănded* at intervals along its course, the *bănds* being from 200 to 400 yards apart, and as far as possible at right angles to the sides of the ravine. (See plates 3, 4 and 5.) Where the ravine is shallow, the *bănds* should be built up to the level of its sides : but in the case of very steep ravines, the *bănds* need not be brought to more than half their depth. An opening or sluice should be provided at one end of each *bănd*, about 3 yards from its top, to admit of the overflow escaping ; otherwise the overflow will sweep over the top of the *bănd* which would in a short time be completely washed away.

How to construct *bănds*.

These ravine *bănds*, or dams, may be constructed in various ways. The "beaver dam," although found to be strong, does not always answer well, as the water percolates through the interstices of the brushwood. First a layer of brushwood is laid down and covered with a layer of clay which is well puddled and beaten down with rammers : and then other layers of brushwood and clay alternately, till the required height is obtained. The sides should be sloped to an angle so as to prevent their being cut away. Another method of *bănding* is to use puddled clay and *sărpăt* grass. A layer of puddled clay is put down and well rammed. On this a layer of *sărpăt*, (or other coarse grass) about 4 inches thick is laid. This process is repeated until the completion of the *bănd*. Clods of earth should not be used for damming, as the floodwater percolates through the interstices and soon washes the *bănd* away. The sluice in the last *bănd* of the ravine requires to be made of masonry owing to the greater force of the overflow there. (See plate No. 6.)

Reclamation of ravine land.

After the completion of the *bănds*, the sides of the ravines may be sloped. Where ravines are not too broad, this can be conveniently done by the *phaura* or hoe, the earth so removed being thrown to the centre and deepest part of the ravine. The banks should be sufficiently sloped to admit of repeated ploughings after every shower of rain. (See plates Nos. 7 and 8.) The earth thus ploughed will wash down into the ravine and silting will begin to take place from the *bănd*. After a very few rainy seasons the ravine will have disappeared, and in its place will be established an undulating meadow over which cavalry and artillery manœuvres will be no longer impossible, while the value of the grass outturn will cover the original expenditure. (See plates Nos. 10, 11 and 12.) The *karáh* (see plate No. 13) will be found very serviceable, where, owing to the breadth of the ravine, it is not possible to use the *phaura*, as in the case of narrow ravines. The *karáh* is of simple manufacture, largely used in the Punjab, and can be employed whenever coolie labour is expensive or difficult to obtain. It is drawn by hand or bullock power, and, where earth has to be carried a long distance, the work can be much more economically done by the *karáh* than by coolie labour. The earth to be moved is first loosened by the *phaura*, or plough, and then collected wherever desired by the *karáh*.

Economical disposal of reclaimed ravines.

The reclamation of ravine land must be done in the most economical way, so as to recover the outlay in less than two years. Land thus reclaimed is very valuable as a grass preserve, for, on account of its excessive moisture, excellent grass crops are produced as regards both quality and quantity. If not required for grass preserves, it can be sublet to zemindars from Rs. 5 to Rs. 15 per acre, without further treatment.

Drainage of low lying lands.

The improvements described above, especially *gátha bănding* and ravine silting, tend to raise the water level and also to assist in retaining as much moisture as

possible in the soil. In many cases, however, the object is the direct opposite of this, and it is necessary to drain off excessive rain water to prevent deterioration of the land. Several places, it will be observed, especially in Lower Bengal, are inundated yearly, and in that state they are only useful for the cultivation of paddy (rice). Such lands require draining, and the first step in that direction should be to ascertain the lowest level, which will be that where most water lodges and from which it is easy to make an escape into the nearest ravine, tank, or river. Through this low-lying land, a deep drain should be cut, connecting it with the place into which it is intended to carry the superfluous water. At right angles to this big drain, a series of smaller drains should run carrying all surplus water into it. Should there be no convenient receptacle for the water, a *bănd* must be built, and the water either pumped over it, or lifted over by the country basket-lifts. (See plate No. 15.)

velling. Irrespective of ravines and the processes of levelling, which have already been described, it is sometimes advisable to level up uneven plots. It would not be economical to remove the hillocks with the *phaura* and basket labour. The simplest methods are to plough the higher portions continuously throughout the rainy season, and to let the loose earth silt down with the flood water. A few years' treatment will, in this way, suffice to level the surface in districts with a moderate rainfall.

CHAPTER VII.

Road-making, Well-sinking, and Erection of Buildings.

This chapter refers chiefly to engineering; but, as in many places in Great Britain and on the Continent of Europe, so in this country, every farmer should be able to carry out his own engineering projects without professional aid.

oad-making. Metalled roads are not absolutely necessary for purely farm purposes, though one main metalled road is often advantageous. All that is usually required are *kachcha* or unmetalled roads which are practicable for bullock carts, grass-cutters, ponies, etc. These latter have one advantage in not necessitating the shoeing of farm bullocks, while of course they are infinitely cheaper. The initial expenditure incurred in metalling roads is great, and their maintenance is also expensive. In case roads are thus metalled, it is economical to lay a foundation of broken bricks or other building débris and place the *kankar* on the top of it. *Kankar* can usually be dug from farm lands, in which case roads can be very economically constructed by the farm establishment when not engaged in other work. The cost of quarrying *kankar* is 3 pies per maund or Re. 1-3-0 per 100 cubic feet. Where culverts are necessary they can also be constructed by the farm establishment. Where it is necessary to bridge ravines, the culvert should be constructed to one side instead of, as is usually done, in the centre. (*Vide* plates 3, 4 and 5.) By this arrangement, all silt takes place in the centre of the ravine while the flood water escapes on high ground.

ell-sinking. At places where water is scarce it may be necessary to construct wells for the cultivation of lucerne, guinea grass, or other experimental crops. In this country the depth of the water level is very variable. At some places the depth is only a few feet, while at Allahabad it varies from 75 to 125 feet. The cost of digging a well 75 feet deep and 7 feet in diameter is about Rs. 8, while the cost of making it *pakka*, that is building up the sides with well bricks or *puttis*, is Rs. 250. This, of course, is what it costs under farm management.

uildings. The expenditure under this heading is usually somewhat heavy, especially if the work is entrusted to contractors. Some considerable engineering skill is required for farm work, but an ordinarily intelligent man will soon acquire the requisite knowledge. Owing to the extensive building operations carried out on a farm, it is absolutely necessary that all farm managers should possess a thorough knowledge of this work. The heaviest item of expenditure is for material, but this can be considerably reduced if a farm manufactures its own bricks instead of purchasing them in the market.

Photo-Block.

Another portion of the main bund on the Macpherson Lake at Allahabad, with second weir in right hand corner.

Road-making, well-sinking and erection of buildings.

Cost of manufacture of bric

The following comparison will show what can be saved by the home manufacture of bricks and lime :—

Market rates.

	Rs.
1,000 bricks (1st class) cost in the market from . .	8 to 10
1,000 „ (2nd class)	5 to 6
1,000 „ (3rd class)	3 to 4½
Lime costs per 100 cubic feet	20 to 25

Farm rates.

	Rs. a. p.
It costs to mould 1st class bricks per 1,000 . . .	0 12 3
Baking by the *pajawah* or country method, provided the loppings of trees and brushwood is available . . .	2 8 0
Total cost of 1,000 bricks .	3 4 3

	Rs. a. p.
Of these about 600 would be 1st class	
250 „ „ 2nd class	
150 „ „ 3rd class	
Giving, roughly, the cost of 1st class bricks per 1,000	4 8 0
2nd „ „ „ „	3 8 0
3rd „ „ „ „	2 0 0

The manufacture of lime from *kankar* dug on the farm and burnt with farm timber, etc., costs about Rs. 10 per 100 cubic feet. In other words, the farm can produce the material at about half the market prices. The material being thus cheaply manufactured and of good quality, the best plan is to give the work out by contract to the actual labourers, thus avoiding the middleman with his high profits. Huts for ploughmen and chowkidars and sheds for farm cattle have to be built, and also sheds for machinery, culverts, sluices, etc.

Cost of build of sheds.

The following are the usual rates in the United Provinces for labour :—

	Rs. a. p.
Pakka bricks, set in clay instead of mortar, per 100 cubic feet—	
1st class	13 0 0
2nd class	11 0 0
3rd class	9 0 0
Pakka bricks set in mortar, per 100 cubic feet—	
1st class	21 0 0
2nd class	19 0 0
3rd class	17 0 0
Kachcha bricks set in clay, per 100 cubic feet	6 0 0
Pointing per 100 square feet—	
Lined	2 0 0
Rough	1 2 0
Framework of bamboos for roofing, with country tiles, per 100 square feet	6 0 0
Sâl wood *ballies* for rafters, 9″ thick at base, per cubic foot	0 9 0
Bamboos, large, for laying across the rafters, each .	8 to 12 annas.
Tiles, country—	
12″ long . . . . per thousand	3 12 0
9″ long . . . . „	1 12 0
String for tying framework, per maund . . .	0 8 0
Bamboos, small, for roofing, from Rs. 1-8-0 to Rs. 6 per 100.	

Only the bes materials to used.

Only the very best material, and that which is not likely to be damaged by insects, should be purchased. All framework and roof timber should be coated with

tar to prevent damage by white ants. It is advisable to mix in with the tar a strong solution of sulphate of copper. It is always more economical to construct substantial buildings, than cheap and temporary ones, however great the initial expenditure may be. For instance, roofs of country tiling require repairing annually, and in a few years the framework needs replacing owing to the bamboos having been insect-eaten and the rope ties having rotted. The *ballies* used in this particular kind of roof soon deteriorate. In other words, such a roof requires to be replaced every five years. On the other hand, a roof of Allahabad tiling, although initially more expensive, is more substantial and durable and does not need any repairs. I would advise the adoption of this kind of roofing for all cattle sheds, servants' houses, etc. For godowns, a galvanised iron roof is best suited, and, as it is everlasting and easily taken down and re-erected, it may be considered the most economical roofing in the market.

In constructing cattle and fodder sheds, and servants' houses, the foundations only need be laid in mortar, while above ground bricks and clay will suffice. The masonry should be pointed with mortar after completion. This procedure obviates heavy expenditure in the purchase or manufacture of lime. All masonry in sluices or culverts should, of course, consist of first-class bricks and lime-mortar.

CHAPTER VIII.

Arboriculture as it relates to Grass Farming.

o riculture.

Arboriculture is to a certain degree profitable for the preservation of grass especially in places where the rainfall is scanty. The first step in planting trees is *to select those under which grass will grow* and which will themselves yield a profit either in the shape of fruit, timber, or fodder. There are many trees under which grass will not flourish; such are the mango, the tamarind, the *pipul*, the *siris* and the plum (*bair*).

babúl and *ham* the trees.

The *babúl* and the *shisham* are the best trees for grass farming as under them grass grows abundantly. The *babúl* is valuable also for the following reasons:—

(*a*) Its timber is most useful for making ploughs, cart wheels, country carts and handles for hoes, *phauras*, rubbish forks, etc.
(*b*) It makes charcoal of the best quality.
(*c*) Its foliage and pods are good fodder for all cattle. The pods especially are very fattening for sheep.
(*d*) It yields gum, and its leaf-rot makes very valuable manure.
(*e*) The prunings are excellent fuel for working the farm engines, etc.
(*f*) It is valuable in assisting in the reclamation of barren land as explained further on.
(*g*) The bark is useful for tanning purposes.
(*h*) After once being planted, it grows quickly and requires no care.

The *shisham* tree stands next in value because: —

(*a*) Its leaf-rot makes good manure.
(*b*) Its timber is valuable for carts, furniture, etc.
(*c*) It grows quickly and also requires little care.

ing and nting of *babúl.*

In sowing the *babúl*, the best seed is that which has been ejected by goats when chewing the cud. The seed should be sown broadcast over the land and, when germinated, the seedlings should be transplanted over the land at intervals of from 50 to 100 feet. The transplanting should be done systematically so that the trees when advanced will not interfere with the working of the mowing machines. The poorest land has been known to become largely benefited merely by the plantation of this tree. The trees should be pruned yearly to encourage quick growth. Where large plantations of these trees exist, it is practicable to provide fuel for the rations of troops by simply lopping them. The *shisham* tree can be transplanted from seedlings during the monsoon.

s for the s of roads.

For the berms of roads, however, the *babúl* is not very suitable, and there the *mango* may be advantageously substituted. There is little grass to destroy on the

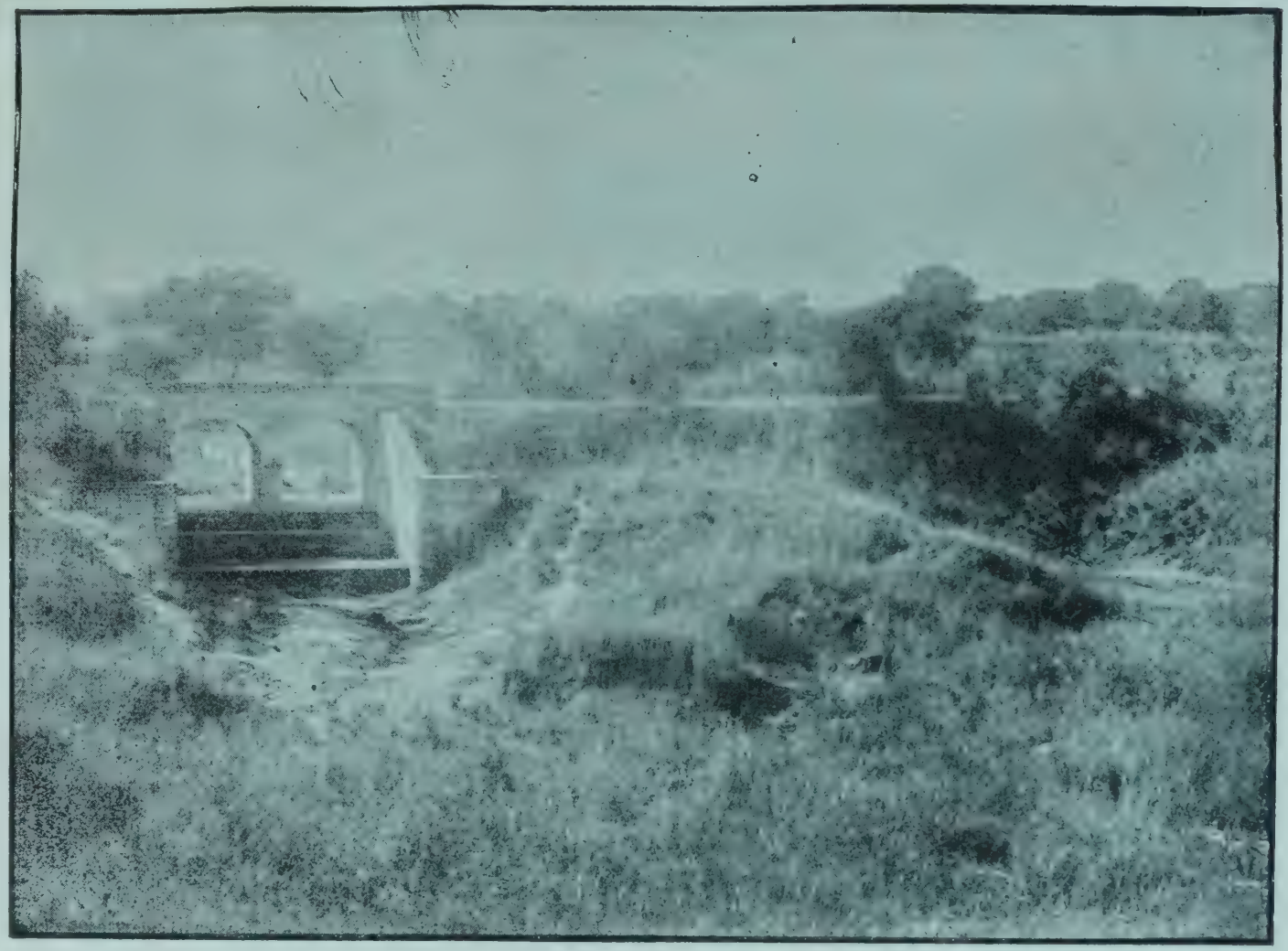


Photo-Block

India Offices, Calcutta.

Head of ravine leading into the Macpherson Lake showing the Waterfield bund and its sluice. The land in the back-ground has been reclaimed by means of this bund. The foreground is still unreclaimed.

road-sides, while the fruit will yield a handsome profit. Choice mangoes are the most paying. It may be argued that fruit growing is not part of the farm business, but any improvement of this kind enhances the value of the land as well as adds to the general appearance of the neighbourhood. *Bamboos*, if planted along the berms of roads, or in ravines, can be turned to valuable account. After four or five years, they can be cut and utilised for building purposes or for any other farm work. Care should be taken not to plant them on grass preserves, because grass will not flourish under their shade. (See plates Nos. 16 and 17.) Bamboo plantation.

Pruning is an art in itself and does not mean simply the cutting away of superfluous branches. The main object in pruning is to shape the tree and cause it to grow to a good head. The *shisham* tree, for instance, will not grow straight unless pruned frequently. If not straight, the timber is of little value. If pruning is neglected when the trees are young, the tendency will be for them to grow into bushes and become stunted in growth. About the second or third year, it is usually advisable to prune the whole of the young shoots from the ground to within three feet of the top of the tree, and at the same time all forked trees should have one prong removed. Pruning necessary.

In the case of large and old trees, all branches should be lopped from the trunk to a height of about twelve feet from the ground, care being taken that the branches are not broken, but neatly sawn off close to the trunk so as to allow the bark to cover the wound quickly. If broken, or if the stumps project from the trunk, water is liable to accumulate in the crevices and rot away the wood which is then rapidly attacked and eaten by insects. In time the insects eat round between the bark and the sap; more water percolates and the tree dies. Thousands of valuable trees in this country are destroyed for the want of pruning and owing to the reckless way in which the natives break the wood for firing. After sawing off the branches, the wound should be smeared with clay and cowdung and subsequently coated with tar and sulphate of copper. This mixture enables the bark to grow rapidly over the part operated on and keeps off insects. The top branches also should be pruned. To encourage all the branches to grow in an upright direction, branches drooping towards the ground should be lopped. It will be necessary to lop a few of the upright branches to admit of air and sunlight penetrating into the centre of the tree, and also those jutting out beyond the tree outline. In short, to obtain a well shaped tree, the trunk should be freed from all its useless feeders and those growing too far out of the perpendicular. How to prune.

The best time for pruning a tree is after it has shed its pods, flower, or fruit, as the case may be, and the necessary implements are a saw and a pruning knife. The hatchet should be sparingly used. When, owing to neglected pruning in youth, it is necessary to saw off large heavy boughs, care should be taken to prop them up, or, when partially sawn through, the weight of the bough will tear away the bark and cause the injury above alluded to. The prunings of all trees should be sold or utilised as fuel for engines. Time for pruning.

On large combined Grass and Dairy Farms, it is always economical to use steam power for chaffing, etc., and the loppings of trees as fuel, instead of coal, will economise greatly. It will take several years of practical training for the student to become an experienced pruner; but the above hints will be helpful. Disposal of loppings.

CHAPTER IX.

Ploughing, Weeding and Irrigation.

In most cantonments the area is comprised of grazing and arable land, the former greatly preponderating. The latter has in most cases been ploughed yearly for centuries past, and would therefore not require ploughing if taken up as grass land. It is best, in the absence of manure, not to disturb such land during the first year, so as to allow the grasses indigenous to the soil to spring up. If manure is available, a light top-dressing might be applied. A heavy one would interfere with the growth of the grass, for the roots being well under the soil, the growth would consequently be Ploughing.

Ploughing, weeding and irrigation.

retarded, and the heavy top-dressing would tend to keep the grass down. Grazing land, which has for many years been over-grazed by large herds of hungry cattle, would be much benefited by ploughing. By this means the top and hard trampled soil becomes loosened, and the stunted grasses are encouraged to sprout and attain their natural height. At the same time ploughing admits of the animal droppings being intermixed with the soil. The rain-water, too, instead of flowing away will soak into the land. Ploughing is especially valuable where manure cannot be obtained, but should not be resorted to in all cases without discrimination. The best time for ploughing for grass cultivation is in the winter months, especially after a fall of rain, or at any time after a fall of rain, when the ground is ready for it. All ploughing should be done as far as possible between October and May, as land ploughed up during this period and exposed during the summer heat to the sun's rays and hot winds is much benefited. This process acts similarly to a light manuring. The natives of India are fully alive to the benefits of ploughing during this period, and the villager's bullocks may be seen at work in the ploughs on fallow land after any shower which has rendered the ground sufficiently soft to admit of its being ploughed.

dvantage of loughing.

eason for loughing.

Ploughing should not be resorted to during the monsoon, except when absolutely necessary owing to failure of winter rains, or in the case of reclamation of barren lands, when no crop is expected and therefore no damage can be done. If incumbent during the rains, the work should be done as expeditiously as possible and only two ploughings should be given, one at right angles to the other. If ploughing is continued late into the rains, the majority of the young rainy grasses will be uprooted; and if done too late during this period, the rainy season grasses are likely to be destroyed, while the growth of the perennial grasses will be retarded owing to the excessive disturbance of their roots. In either case, the crop will not receive the full benefit until the following year. So it is preferable not to attempt ploughing during the rains. In Great Britain, pasture land is seldom disturbed as it takes from ten to twelve years to establish it.

loughing not be done in ie rains.

nger of late oughing.

If the land is ploughed during the rains the *páhátá* (see plate No. 18) should not be subsequently used, as this tends to obviate one of the principal effects of ploughing, by pressing down the soil and thus shutting out the water which would in the ordinary course lodge in the furrows. A steel harrow is far more suitable.

he use of the *hátá* in rains ohibited.

Farm bullocks or Government transport should be utilised as far as possible, and only in very exceptional cases should animals be hired for this purpose. It is difficult to exact good ploughing from contractors, as naturally their object is to spare their bullocks, and, while ploughing a sufficient area daily, the work is done irregularly, the furrows not being deep, and large spaces being left between them. In fact, they scamp the work. Even under the most rigid supervision, the native hired ploughman succeeds, by some one of his numerous methods, in so adjusting his plough as to ease his animals while the plough merely scratches the surface; this is usually done (see plate No. 19) by shortening the draught or altering the angle at which the ploughshare is set on the shaft. Country ploughs are readily adjusted for either deep or shallow ploughing. At the end of the shaft where the yoke for bullock draught is attached, are three holes about four inches apart. The yoke is attached to the shaft or pole by means of a short stick passed through one of these holes and connected to the yoke by a short rope. By shifting this stick to the front hole the ploughing will be deep owing to the more obtuse angle at which the ploughshare meets the ground. Conversely, the moving of this stick back to the last hole, raises the shaft and causes the ploughshare to meet the ground at a more acute angle, with the natural result of shallow ploughing.

rm or Govern- ent bullocks to used.

ow to adjust e country ough.

Experience has proved that the native plough is the best suited to India, and it is bad policy to purchase expensive ploughs imported from Europe or even modified English ploughs made in this country. Of course, for garden purposes, where a greater tilth is requisite than on pasture or meadow land, the use of an English plough would be of advantage. Such authorities as Professor Wallace, Dr. Voelcker and others are agreed upon this point. Throughout India ploughs of different patterns are to be found, each specially suited, from generations of native experience, to the depth of soil of the district as well as to the size of the draught animal obtainable in

ie native ough most itable.

Photo-Block

Survey of India Offices, Calcutta, 1932.

Overflow in the Macpherson Lake at Allahabad, with galvanised net frames to prevent fish escaping. Without these escapes, the water would flow over the bund and wash it away.

Ploughing, weeding and irrigation.

the district. Some of the Indian ploughs in use, as may be observed, are useless, in their present state, but are susceptible of improvement without much alteration of design. In some parts of India the soil is very shallow, and if on such land a deep plough were used, it would result in too much of the sub-soil being brought to the surface, and the prospect of the expected crop would thereby be damaged.

Deep ploughing unnecessary.

In the case of grass cultivation deep ploughing is not so necessary as in the case of crop cultivation, and the native plough is suitable for this purpose. A very useful implement for grass cultivation in this country is Howard's Cultivator. This machine scarifies the surface to the desired extent. The cost of an English plough varies from Rs. 60 to Rs. 120, while the native plough can be purchased at from 12 annas to Re. 1-4-0 each.

Ploughing not absolutely necessary where manure is plentiful.

As explained further on, ploughing is not absolutely necessary for grass cultivation where plenty of manure is available, except, of course, in the case of reclamation of barren lands where deep and constant ploughing is necessary. In the case of these lands the object is to *make* soil by exposing continually a quantity of the sub-soil to the action of the air, rain and sun. (Ploughing without *gáthá bánding* or manuring, is barely remunerative) and instances are known where large expenditure has been incurred in this way.

Weeding.

Weeding is just as necessary in the cultivation of grass as in the cultivation of crops. In both cases weeds retard the growth of crops by choking them, by excluding the heat, light and air from them, and by robbing the soil of a portion of the chemicals which would otherwise be absorbed by the crop. It is false economy to neglect weeding. Indeed complete failure in grass cultivation is traceable to this cause. Land is heavily manured, and the weeds are allowed to grow up with the grass, until the whole area becomes overgrown by weeds and then the method of manuring is condemned, whereas had the weeds been removed when young and small, the result would have been very different. If weeds are not uprooted the outturn of grass will be small; the quality of the fodder will be inferior owing to the admixture of weeds; and a smaller number of cuttings will be obtainable. The weeds will also seed, and the following year their growth will be still greater and the loss more serious. It may be noted that weeds grow quicker than grass and consequently oust the grass in time.

Evils resulting from neglect of weeding.

Manuring increases growth of weeds.

It will be observed that unmanured land grows comparatively few weeds, while heavily manured land produces weeds abundantly. In the latter case, especially, they should be immediately uprooted or cut down and siloed. Cases have occurred where much expense has been incurred in heavily manuring the land, but owing to the neglect of weeding in the first year, only one crop was obtained and it was inferior and unfit for fodder owing to the admixture of weeds. The weeds had seeded before the crop, with the natural result that the following year the land produced a remarkably fine crop of weeds and the cultivation of grass had eventually to be relinquished. These bad results are distinctly traceable to the attempt to save a few rupees on weeding in the first instance.

Methods of weeding.

(Weeding can be economically done by the following methods. The cost of uprooting weeds by coolie labour where they are thickly grown, would be prohibitive, but as most weeds when siloed form excellent fodder for horned cattle, the best method is to cut the entire crop of grass and weeds, and silo it. This will obviate the cost of weeding. It often happens that land requires as many as three or four weedings, because the weeds have been allowed to seed. A cheaper method is to allow the villagers to remove the weeds without payment. They chaff the weeds thus collected and mix them with dry food, such as *bhoosa* or dry *karbi* and feed them to their cattle. Where the crop is almost all weeds owing to neglect, a good plan is to cut the whole crop with the mowing machine and allow it to rot on the land in which state it serves as a light manuring. In the case of land from which only one crop is obtainable for hay, the only possible method is to weed by hand. This can be done either by contract or by daily labour.

Irrigation.

As a general rule, irrigation is not absolutely necessary in grass farming, where the rainfall is favourable. It is valuable, however, where the rainy season is

unfavourable. On the other hand irrigation without manuring is not remunerative. Instances have been known where experiments of this kind were tried with *dub* grass during the summer months, and the income derived was very much less than the outlay.

Modes of irrigation.

There are several means of irrigation, the most important of which are well irrigation with the *mote*, the Persian wheel, the Pánjab system of *arat*, canals, pump irrigation and the various country water-lifts. The most expensive of these is the *mote* or well-bag system and it is also the slowest; but in spite of these drawbacks, it is profitable when employed. On manured or cultivated grass lands, canal irrigation is perhaps the most favourable. Where the water in wells or tanks is near the surface, and the supply is unlimited, pumps can be satisfactorily employed for irrigation purposes. Only in places where owing to a scanty rainfall fodder is scarce and expensive, and green grass is required, should irrigation be resorted to. The land to be irrigated should be first trenched with town rubbish and sown with *dub* grass (*cynodon dactylon*). Two or three floodings a month would be necessary and the land would continue to yield excellent crops of grass even during the hottest months of the year.

CHAPTER X.

Manuring and Top-dressing.

Manuring for grass.

The system of manuring for grass cultivation differs entirely from that required for crop cultivation. In the case of grass cultivation "long or green" manure is the best suited; whereas, for crops "short or rotted" manure is required.

In the former case the roots of the indigenous grasses are in the ground already. They are perennial, that is to say, they grow from year to year from the same root-The plants are therefore strong and do not need the readily assimilated food that is necessary for the tender plants of the young crop. In the case of grass, the manure applied is intended to last for many years, while crops which are only in the ground for a short time need immediate nourishment. (The dung-pit process of storing manure is altogether unsuited for grass farming.) The pit itself is a considerable item of expenditure, while the process of covering it with a shed or of placing alternate layers of earth and manure adds still more to the expenditure; as also does the double cost of carting the manure to and from the pit. Apart from the question of expenditure, the process of fermentation is lost to the land and a considerable part of the valuable constituents of the manure is lost in the pit. The loss is greater in cases where the manure is not carefully covered and sheltered. This fact is now becoming recognised in England. Large quantities of valuable manure in the shape of litter of cavalry and artillery lines are partially lost owing to being pitted and allowed to rot before being spread on the land. For financial reasons the poorest land should always be manured first.

Dung-pits not advisable.

Advantages derived from manuring.

The effect of manuring is to improve the outturn of grass both in quantity and quality. It also causes the grass, which, before its application was poor in nourishment, light in colour and coarse in foliage, to become rich, dark and succulent. It has besides the effect of ousting inferior or coarse grasses, and of encouraging the growth of superior ones. On the estates of Sir John Lawes and Sir Henry Gilbert at Rothamstead, this fact has been proved practically by extensive experiments. A field of inferior grass in India when heavily manured yields a mixture of *dub*, *janewar* and *unjan*. It is possible by certain methods of manuring grass land to obtain rich succulent crops of grasses which will continue to yield a heavy outturn for a long series of years. It will be found far more economical to attain this object by a heavy application of manure than to fritter away the money on numerous light applications. This view is held by all leading agriculturists in Europe.

The great desideratum in grass cultivation is to keep the top surface soft, as already explained in the chapter on losses and gains to soil. It should be borne in mind that before any land is manured under any system, it is necessary to apply the

Photo-Block. [illegible]

Showing the raviny land reclaimed by the Waterfield bund, growing a *rabi* crop immediately after reclamation.

gáthá-bándi system for reasons previously explained. The various methods of manuring grass lands usually followed are :—

1. Top-dressing with town rubbish.
2. Top-dressing with horse litter.
3. Top-dressing with old grass, refuse, silage, indigo refuse, etc.
4. Top-dressing with cow-dung.
5. Trenching with town rubbish.
6. Trenching with horse litter.
7. Trenching with blood and slaughter-house refuse.
8. Trenching with night soil (deep and shallow systems).
9. Stock manuring.
10. Flooding with sewage.
11. Green crop manuring.
12. Burning.
13. Bone-dust.
14. Warping.

Top-dressing with Town Rubbish.

This is, on the whole, the quickest method of manuring for the production of grass. *Town rubbish* is the refuse collected from the houses and streets of the native cities, bazaars, barracks, cook houses, etc. It consists chiefly of ashes, vegetable refuse, leaves from confectioners' shops, bones, horse litter, cow-dung, paper, broken chatties, etc. This rubbish is removed in its green state direct from the city in carts and deposited on the land. It should never be accumulated and allowed to rot, for in its rotted state it is far inferior to green manure, and, moreover, is less durable, being liable to be washed into ditches and drains by heavy rainfall.

Time for top-dressing.

The time for top-dressing is from November to June, between the hay-making season and the commencement of the monsoon. If, however, the manuring is not done until the rains have well set in, no crop will be obtained till the following year, while at the same time the ordinary crop of grass (say 100 maunds per acre), which would have been obtained without manuring, is lost. Manuring during the monsoon should therefore be confined to lands from which a crop cannot be expected. Manure, applied before the hot summer months set in, acts as a shade to the grasses and encourages them to grow gradually until the rains and thus obtain a good start, and it also prevents excessive evaporation of moisture. If the operation is conducted in this manner, a full crop consisting of about six cuttings and amounting to about 800 maunds* per acre will be obtained the first year. The land benefits from the day the manure is applied.

Mode of top-dressing.

The land to be operated on should first be well ploughed, in order to open up the soil and allow the manure to settle into the furrows. At the same time, the land should be put into plots by the *gáthá bándi* system to prevent loss of manure by flooding. The entire surface is covered with a layer of manure $2\frac{1}{2}$ inches thick. For spreading, two sweepers on Rs. 5 a month with forks (see plate No. 20) are sufficient to spread out 10 tons of manure or, say, 280 maunds in a day. Green rubbish thus spread out, will, when thoroughly rotted, decrease to a layer of soil half an inch in thickness. The $2\frac{1}{2}$ inch layer of green manure when rotted, is so consolidated as not to be easily washed away by water. If, however, rotted manure is available for disposal, it should be spread to a depth of $1\frac{1}{2}$ inches. The half inch of soil formed by the above application is sufficient to keep the top surface soft for many years. This has been found by repeated experiments to be the correct thickness of manure, to attain the best results in outturn and duration. If a smaller quantity is applied, it is easily washed away when decomposed, and the surface soon becomes hard. If, on the other hand, a greater thickness is applied, the indigenous grasses will not penetrate through it the first year, and in consequence the crop will consist only of weeds which have germinated from seeds in the manure, the removal of which will entail heavy expenditure. Irrespective of this, it would be extravagant to apply more manure than is necessary. We may, then, take it for granted that $2\frac{1}{2}$ inches is the correct thickness.

* There are about $27\frac{1}{2}$ maunds in a ton.

Top-dressing with town rubbish.

The manure should be covered.

It is generally advisable, especially in the neighbourhood of cantonments, to cover up manure immediately it is spread with about ¼ of an inch of dry earth. This earth is excavated from high mounds on the plot, or in case there are none, a few depressions must necessarily be made in order to obtain sufficient earth. The holes thus made are filled with town rubbish and covered over with a layer of manure. The earth is thrown over the manure by coolies from baskets, with a twist of the hand. This covering effectually prevents paper from blowing about, and is the means of lessening any offensive smell which might arise.

Top-dressing deprecated on sanitary grounds.

As a rule, this plan of manuring should not be resorted to in the immediate vicinity of barracks, etc., though it is extremely doubtful whether any ill effect would follow. It has been carried on for years in some cantonments without any ill effects. In fact, it is far less objectionable than the method usually adopted in cantonments of merely accumulating refuse in large heaps close to barracks without any covering whatever. In these days of sanitary reform, it is advisable to trench all manure whenever the farm is capable of meeting requirements.

Sowing grass not necessary.

There is no necessity for sowing grass, not even *dub*, on land manured by this system, as the roots of grasses are in the ground and will germinate through the manure after a very short time. Many instances have occurred where poor land bearing only inferior grasses and treated in this manner has produced heavy crops almost entirely composed of *dub*. This bears out what has been said above. The crop of grass obtained off such land is termed "mixed herbage" and it has been proved by experiments carried out by Sir Henry Gilbert at Rothamstead on Sir John Lawes' estate that "mixed herbage" is the best fodder for all animals. The land should not be ploughed after manuring. Ploughing would, no doubt, be the correct procedure in case of crops, but it is detrimental to land required for grass cultivation. Many instances have come under observation, where land top-dressed had been ploughed in order to intermix the manure with the soil resulting in reduced outturn. The top-dressing thus disturbed, soon lost its efficacy.

Ploughing prohibited after top-dressing.

The expenditure incurred in this system of manuring land should be considered as a more or less final charge, the benefits of which will continue to be derived throughout a series of years. This is one of the methods of manuring which obviates the necessity of ploughing. Whenever the system of top-dressing is referred to, it must be remembered that the method described above is intended.

As land properly top-dressed will yield a good outturn up to eight years, it should not be distrubed until the expiration of that period, unless the outturn has been reduced to that obtained off unmanured land, in other words, until it has degenerated to its original state.

Another system of top-dressing.

There is, however, another top-dressing, largely practised on many farms, which is not capable of producing such favourable results. In this system, the land is generally ploughed first and a very light top-dressing of manure applied, so light indeed that the surface is exposed throughout, and many places are left quite bare. This top-dressing is frequently adopted with a view to making the manure go further, but the expenditure incurred on it is simply money thrown away, especially if the *gátháběndi* system has not been previously applied, in which case most of the manure is washed away. Even under the most favourable circumstances the land is not benefited for more than two years. If rotted manure is thus applied, the results are even more unsatisfactory owing to the greater likelihood of the manure being washed away by flood-water.

Cost of top-dressing.

The cost of top-dressing an acre of land is roughly as follows, but it will of course vary according to local circumstances, especially with regard to the cost of manure:—

	Rs.
Long manure 150 to 200 cart-loads of 1 ton each, including cartage at 12 annas per cart-load (this is the outside rate), say . . .	140
or	
Rotted manure 105 cart-loads of 1 ton each at Re. 1-4 per cart . .	140
17 Sweepers or days at 3 annas a day, say	3
1 Beldar at 2½ annas and 20 coolies at 2 annas each, for covering with earth	3

Photo. Block. Survey of India Offices, Calcutta, 1902.

This shows the greater portion of the land (12 acres) reclaimed by the Waterfield bund, on which a *rabi* crop and trees have been planted. The ravine has completely silted up, and its perpendicular cliffs have all been converted into undulating land.

Top-dressing with horse litter and with grass, indigo refuse, etc.

Top-dressing with Horse Litter.

The land as in all cases of manuring should first be divided into plots by the *gátha-bándi* system. Horse litter is best disposed of by mixing it with town rubbish and using it for trenching or top-dressing as already described. Where, however, it is not convenient to mix the horse litter with rubbish owing to difficulties of carting (as is generally the case in stations where cavalry and artillery are located), the horse litter may be disposed of separately, care being taken that it is not previously rotted. It is taken direct from the stables to the land where it is spread to a thickness of two inches. If spread thicker the growth of the grass will be greatly injured, as the heat from green horse-litter is very great. This manuring is remunerative, but it cannot be compared with town rubbish top-dressing in respect to outturn or duration. Land treated by this method will yield about 500 maunds per acre in four or five cuttings the first year, diminishing gradually till the eighth year, when it should be trenched.

Horse litter be used fresh.

Native Cavalry litter preferred.

It may be here noted that there is a good deal of difference between the litter obtained from British Mounted Corps and Native Cavalry. The latter is far more valuable owing to the large admixture of bazaar sweepings, ashes from followers' cooking, etc. In most cases it is advisable for the farm to pecuniarily assist in the removal of the rubbish from the Native Cavalry lines. It will thus be possible to have it removed to any reasonable distance from the lines to the advantage of both parties. This kind of manuring can be carried on close to barracks, without the necessity for any covering of earth, as it is inodorous.

The first crop obtained from land so manured should be cut before it is a foot high, because the heat generated from the manure will wither and discolour the lower portion of the foliage, if the grass is allowed to grow long. The cutting of the crop at this stage also allows the sun and air to reach the manure and thus hasten its decomposition. The second crop may be allowed to grow to its normal height.

When to cut the first crop.

Weeds will come up plentifully with the first crop, which is another reason for cutting early. Sowing is not necessary, as explained in top-dressing with town litter, and similarly the land should not be ploughed after manuring. As in other forms of top-dressing, irrigation is not advisable. The cost of an acre of land top-dressed by this method would merely mean the cost of the manure, some 150 cartloads. As a rough guide it may be noted that a battery of artillery provides two country cart-loads of litter daily or say one cart to every 50 animals, which works out at a cost of about 3 or 4 annas per cart-load per diem.

Top-dressing with Grass, Indigo Refuse and Green Crops.

This refers to inferior or spoilt hay, weeds from grass lands, bad silage, indigo refuse, and refuse stable grass unmixed with dung. When possible, this should be put on the land mixed with other manure, but where this is not practicable it should be spread two inches thick. It should not be ploughed in after being spread, but the land should have been previously ploughed. This land will not require sowing, as it will be found that the seeds of the various grasses in the refuse will germinate as well as those grasses of which the roots are already in the ground.

Land so treated will not require again to be disturbed or manured till after three years. Three crops may be expected the first year, with a total outturn of from 250 to 350 maunds per acre. Top-dressing with indigo refuse is very valuable to the soil, and it is much used in the indigo districts by planters in the cultivation of indigo as well as other crops. The cost of this dressing is trifling as it is obtainable free; the only expenditure being for carting and labour. It is a useful manure where town rubbish and night-soil are not procurable, or where their use is prohibited.

Results of the treatment.

Green crop manuring is another cheap method and can with advantage be adopted where other manure is not available or where the land is overgrown with coarse grasses, such as *kansa* and *khusa*, which it is desired to eradicate. Barren or very poor land benefits especially from this form of manure. The best crop for this purpose is any one of the *leguminosæ*, such as *babúls*, hemp (*sunnai* or *patawah*),

Green crop manuring.

indigo, etc. The crops should be sown thickly, and when they have attained a height of about four feet, they should be cut down and allowed to rot on the surface. If water is readily available, the land should then be flooded to hasten decomposition, and the refuse subsequently ploughed into the land in a semi-decomposed state. Land overgrown with *kansa* and *khusa* has been freed of them by this simple process, which is infinitely cheaper than attempting to uproot them. It should be adopted for clearing land where the weeds cannot be dug out. In the case of *babúl* plantations, the height of four feet will only have been attained after about three years, but this should be applied to barren land. This form of manure is more suitable for crops than for grass.

Top-dressing with Cow-dung.

Drawbacks. This top-dressing is inferior to any of the various methods described. Fresh cow-dung applied to the land encourages largely the growth of weeds, and in its wet state it loses much of its valuable constituents owing to evaporation. In heavy rain a considerable portion is readily washed away. This manure has not the effect, which is so valuable in grass cultivation, of softening the top soil, nor is the fermentation great.

How to apply it. If it is considered necessary to utilise cow-dung on grass lands owing to other manure not being available or as a means of disposing of it, it should be spread to the thickness of an inch and a half on the land or trenched. It is advisable to mix it with other manure, and apply it to the land after ploughing. If the cow-dung is obtained free, *e. g.*, from Transport Lines and other Government animals, the only expenditure incurred is that for spreading it, which would amount to about Rs. 10 per acre. Land manured by this process will yield 250 maunds per acre in two cuttings and will not need re-manuring till after three years. Cow-dung is more useful and valuable for crop cultivation than for grass.

CHAPTER XI.

Trenching with Town Rubbish.

From a sanitary point of view this is perhaps the best method of disposing of town rubbish. It has frequently been carried out in hospital compounds, private compounds, and, at Allahabad, even up to the door of Government House, without any injurious results. The rubbish should be used in its green state, as in the case of top-dressing, because the fermentation emanating from the manure below, assists in breaking up the clods of earth thrown on it from the trenches. The benefit derived from the process of fermentation is more marked in this case than in top-dressing.

The following methods of trenching are generally practised :—

(1) Shallow trenching.
(2) Deep trenching.
(3) General Ottley's system.

Shallow trenching. 1. As the SHALLOW TRENCHING SYSTEM has been frequently proved to be by far the best method, it will perhaps be advisable to describe it first. The process is as follows :—The land is first *gátha-bánded* and then successive trenches are dug, 6 feet broad and 1 foot deep, over the entire surface of the plot. The width is fixed at 6 feet, merely because it is found to be a convenient width for depositing a cart-load of rubbish and thus economising labour in spreading. The earth of the first trench is thrown on the top of the bank of the *gátha-bándi* embankment (see plate No. 21).

The manure is spread 9″ thick, and the next trench is commenced parallel to the first and without any intervening space. The whole of the earth excavated from this second trench is then thrown over the manure in the first trench, and the second trench similarly filled to a depth of 9″ with manure. The third trench is excavated and filled with manure in the same way, and the process is repeated until the whole plot is completed. The earth from the first trench is used for covering the grass seed when sown.

Photo. Block.

A glimpse of the unreclaimed ravine land below the Waterfield bund. The sides of the ravines are steep cliffs, almost perpendicular, but they are hidden in the plate by the long coarse grasses and trees in the foreground. There are also many large side ravines leading into the main channel which are not visible.

Trenching manure.

2. The DEEP TRENCHING SYSTEM, although more expensive than the shallow one, is not so profitable for the following reasons. The trenches being two feet deep, excavation is more expensive and the quantity of manure expended is much greater. A considerable portion of the value of the manure is wasted, for being so deep the shallow roots of some grasses cannot reach it, and the 2 feet thick covering of earth is too thick to enable the manure to affect it in the same manner as it does in the shallow trench system; and consequently the top surface becomes hard, to the detriment of the crop. The extra expense of this system does not justify its adoption, as it is productive of no better results as regards either outturn or quality of grass, than the shallow trenching, and it is not more lasting. Deep trenching

3. The expense of GENERAL OTTLEY'S SYSTEM of trenching renders its adoption prohibitive. After excavating the entire area to a depth of 18 inches the earth is collected into large heaps scattered over the plot. This earth is then passed through lime sieves, in order to remove the roots of the *motha* grass. This grass grows everywhere and germinates from its numerous bulbs, all of which are connected by very fine thread-like roots extending many feet below the surface. The manure is then spread at a depth of 9 inches over the bottom of the excavation and covered evenly with the sifted earth. The land is levelled, rolled and sown with *dub*, as in the shallow system. The sifting is an expensive process more especially because it fails to attain the desired object of removing all the roots. The total cost of manuring and sowing one acre is about Rs. 1,000, which places it beyond the range of practical farming. General Ottley's system of trenching.

The best season for trenching is before or during the hot summer months, in order to expose the earth thrown up from the trenches as long as possible to the action of the sun and atmosphere. The top surface of the earth, covering the manure, is chiefly sub-soil, which will improve by exposure. The plot thus operated on will continue to subside as the clods of earth dissolve and the manure below decomposes. This is hastened by flooding or repeated heavy showers of rain. It is therefore essential before levelling, that the manure and earth be thoroughly saturated, so as to allow the ground to subside before it is sown; otherwise if the sowing is done previously, the ground will settle unevenly, and a second levelling and sowing will be needed. The season for trenching.

It is advisable where canal or other inexpensive means of irrigation is readily available, to flood the plot. After two or three floodings at intervals, the land may be levelled by hand labour or ploughing. When the land has settled evenly another flooding should be applied; and when sufficiently dry, *beldars* should be employed to collect some of the finer earth off the surface into ten or fifteen heaps scattered over the plot. The earth is collected in this manner to avoid the expense of carrying it from a distance and it is used for covering the grass and seeds sown. In sowing grass, seed is not necessary. The *dub* grass either whole or chopped into small lengths of 3 or 4 inches and thrown broadcast over the land, is sufficient. The grass should be spread over the surface, just sufficiently thick to leave the earth barely visible, and the earth from the collected heaps lightly sprinkled over the land by coolies. Great care must be taken that it is not too lightly covered with earth, as, in the absence of rain, the grass would wither. On the other hand, if the grass is too thickly covered with earth, it will not germinate. How to secure rapid cultivation.

After sowing and covering with earth the land is again flooded at intervals of a few days. When the grass has commenced to germinate, one flooding weekly will suffice: when about 4 or 5 inches high, the crop should be cut down, and allowed to lie on the ground. This grass can be cut with the *jhabau* without injuring the roots which are very weak at this stage; and if another flooding is applied immediately afterwards, it will soon germinate. In this manner a good crop may often be obtained before the commencement of the monsoon, and even during the first year it will be possible to obtain an outturn of not less than 800 maunds, or 29 tons per acre. Where irrigation is not available immediately after trenching, to prepare the land for sowing, such good results cannot be expected the first year, as the whole of the operation of levelling and sowing would have to be deferred till the land had subsided. In many cases where the rains have partially failed, grass cannot be sown until the Flooding.

following monsoon. This has occurred during recent years of drought, when the areas trenched could not be levelled or sown for want of rain.

When grass should be sown.

When dependent on the monsoon, advantage must be taken of showers for sowing. If grass is sown after a shower, and it does not rain again for three days, the *dub* will not all germinate, and the sowing will have to be repeated. Therefore, sowing should be done while it is raining and likely to continue raining for some days. Another method of sowing is to purchase roots of *dub* grass, mix them with cow-dung and smear the mixture over the land. This entails unnecessary and heavy expense, as the ordinary *dub* grass chopped up will germinate just as well. Sometimes even *dub* seed is sown, but this is a still more expensive method.

Under this shallow trench system the cost per acre is about Rs. 500 :—

	Rs.
600 cart-loads green rubbish at 12 annas per cart-load . .	450
Trenching at 10 annas per 1,000 cubic feet	28
Levelling and sowing	20
Total . .	498

This is an outside estimate as the rate at which manure has been calculated is exceedingly high.

Although no *motha* grass may have been sown with the *dub*, it will be found that it will appear with the first crop of *dub*, and after a few years other coarse grasses will also appear. Often *barwi* and *bansi* spring up and these, being strong grasses, should be weeded out without delay, otherwise, in time, they will oust the *dub* and other fine grasses. Superior and finer grasses should not, however, be weeded. Where it is intended to establish a lawn, all other grasses except *dub* should be weeded out. This is the best means of manuring for a lawn where the grasses other than *dub* can easily be weeded out. A farmer, however, would not attempt to weed such land. After completion no trenched land should be ploughed or disturbed, but it may be irrigated when practicable. The land will not need re-manuring for at least twelve years, and for the first three or four years it will continue to yield, without irrigation, from six to eight corps annually, amounting to about 800 maunds per acre. With irrigation, the outturn and number of cuttings will be considerably increased.

In very cold districts, it will be observed that the grass turns quite brown after a frost: this may be avoided by irrigation prior to a fall of frost.

Trenching with Horse Litter.

Horse litter should not be used alone when it can be readily mixed with other manure. The process is exactly similar to that described in the case of town rubbish. The results are, however, inferior. The outturn is from 600 to 700 maunds per acre, and will not require re-trenching for eight years. When it is intended to re-manure land previously trenched, it is advisable to top-dress so as not to disturb what little of the manure is left within a foot of the surface. Trenching with litter has this advantage over top-dressing with the same material, that weeds will not appear in such quantities. The cost per acre will be similar to the cost of trenching with town rubbish, the only variable item being the cost of manure.

Trenching with Blood and Slaughter-house Refuse.

Of all manures which are ordinarily available, this is by far the most heating, and therefore requires to be well diluted with water. Insufficiently diluted blood has been trenched, with the result that nothing could be grown on the land for several years, and then only by well pulverizing the soil and admitting air and water into it. When well diluted, however, it is a very valuable manure, especially for crops, fruit, or vegetables. The trenching is done exactly in the same way as for night-soil, and if grass is especially desired, it can also be sown with *jowar* and *dub*. The outturn, however, will be inferior to that obtained from night-soil, and the land will more quickly require re-manuring.

Photo-Block. Survey of India Offices, Calcutta, 1902.

Ravine land ten years after reclamation. The flow of water through the original ravine was checked by the bund on which bamboo trees are growing, the ravine has silted and no trace whatever is left of it. The land is regularly cultivated and brings in a very favorable income.

Trenching with Night-soil.

Deep System.

The old method of deep trenching was usually as follows:—

The old method of deep trenching.

Trenches, 1 foot deep and 1 foot wide, were prepared, into which (according to regulations) 3 inches of night-soil had to be deposited. The length of trench actually required to receive the contents of a filth cart of 60 gallons, or say 10 cubic feet capacity, would therefore be about 40 feet, allowing a depth of 3 inches of night-soil. It is scarcely likely that a labourer like the cantonment *beldar* would expend so much labour in excavating a trench of this length even if he had time, and it is not likely that he would take the necessary care to ensure the night-soil being placed at a depth of only 3 inches. On uneven ground with a drop of even 1 inch in 40 feet, with the best intentions it would be impossible to do this. It was quite impossible with any amount of supervision to ensure the regulation being strictly carried out, owing to the circumstance above explained. In any case, the usual result was, that small trenches of some 12 feet in length were dug for each filth cart and the trenches filled to the brim, the contents often overflowing, especially during the rains. The earth was then piled on the top and naturally sank through the liquid manure, leaving the lighter substance, the excreta, to come to the top, and the liquid matter to overflow. The result may be easily imagined. The system was no doubt a satisfactory one for the cantonment sweeper and *beldar*. Apart from sanitary considerations, it was a failure as regards grass cultivation, for cattle deliberately refused the grass grown on this trenched land the first year, and sometimes even the second year. Under such treatment the land needed a heavy rainfall, and it was very noticeable in a year of drought that the crop cultivated seldom came to maturity owing to its being burnt up through the heat in the soil, caused by the night-soil not having decomposed.

Shallow System.

The shallow trench system, which is described below, is now sanctioned by regulation. Wherever the method is practised correctly, it is sure to give every satisfaction, and where it is not working satisfactorily it is certain that the system has not been followed. As a substantial proof of the correctness of the system, a horse galloped over ground recently operated on, should not make an impression in the soil deeper than two inches. It is a misnomer to term this the shallow trench system; a more appropriate term would be "surface disposal of night-soil."

In several cantonments where objection was made to the system after experiments, it was observed that, owing to some misunderstanding, a modified form of deep trenching had been tried and not the Allahabad shallow system. This was at once perceptible from the fact of horses sinking almost knee-deep into the soil when taken over it.

Method of disposal.

The superficial area of each space required for the contents of a Crowley pattern filth cart, containing 60 gallons, has been found to be 80 square feet. The area required per cart of other dimensions can be readily calculated on this basis. The most suitable dimensions for this 80 square feet are 16 feet long and 5 feet broad. Three inches of the top surface of this space are removed and placed on the embankment of the plot nearest to which the first line of trenches is dug. The land is of course first *gáthá bănded* and the trenching begun close to the embankment. The sub-soil thus exposed is well pulverized to a depth of at least 9 inches. When the contents of the cart are tipped into the centre of the trench, the liquid matter rapidly soaks into the loosened soil, while the solid excreta remains on the top. This solid matter is less than $\frac{1}{8}$th inch thick. Three inches of earth are then removed similarly from the top of the next trench, which is dug parallel to the first with no intervening space. The soil dug from the second trench is thrown over the night-soil in the first trench and the process repeated. (See plate No. 23.)

The above generally applies to cantonment filth-carts which contain a large quantity of urine and cook-house water, the night-soil comprising only about $\frac{1}{3}$rd of the contents

Trenching manure.

The municipal filth-carts employed in bazaars and cities, on the other hand, largely contain solids, as, owing to defective sanitary arrangements, the liquid is not collected. In this system, therefore, there is no necessity to pulverize the bottom of the trench.

pervision plified.

It has frequently been argued as an objection to the surface form of disposal that it is difficult to supervise. Those who thoroughly understand the method, are agreed that it can be more effectively supervised than any other system. All that the overseer or supervisor has to do, is to see over-night that sufficient spaces, according to the daily number of filth-carts, have been prepared; and he can easily ascertain if the soil has been sufficiently pulverized by thrusting his stick into each pit. He need not return till the following evening, when he should see that the areas, or spaces, prepared have been properly filled and covered, and that sufficient trenches for the next day are dug. If he should neglect to do this, the sweepers will naturally empty two carts into one space, to save labour in digging. Experience teaches that

ited to every son.

it is by far the best known system for both wet and dry seasons. It has been carried out at Allahabad for 14 years without any hitch, and on various descriptions of soil, including stiff clay, black-cotton, and sand. At Allahabad the success achieved is mainly due to the Farm having remunerated the cantonment sweepers and *beldars* engaged in this work; and unless this is done elsewhere, it will not be possible to ensure the work being carried out satisfactorily and in accordance with the instructions given above.

proved by entific thority.

The night-soil thus trenched decomposes in less than a week, and even after three days all effluvium disappears. Before the system was pronounced safe on sanitary grounds, many successful experiments were made by Surgeon-Colonel Martin, who was Principal Medical Officer of the Allahabad District at that time. The trenching grounds have been inspected by most of the medical, sanitary, and other scientific authorities in India, including the Principal Medical Officer of His Majesty's forces, all of whom have expressed their unqualified approval of the system.

ar or millet to sown with *b.*

Crops can be successfully grown immediately after trenching, and even in the cultivation of grass, the first crop is greedily eaten by cattle. Such land should be put down to grass without ploughing. As regulation demands the sowing of a *sorghum* crop on land trenched with night-soil, this should be done without disturbing the soil and exposing the newly buried night-soil. At Allahabad, *sorghum* and grass are sown together, as described below. *Juar* is first sown broadcast with about 7 lbs. of seed to the acre. The chopped *dub* is then sprinkled over the seed and the whole lightly covered with earth as described in the chapter on top-dressing with town

hen the crop ould be cut.

rubbish. It will be found that these two will grow together, and when the *juar* has attained a height of about 4 feet, and the grass a height of 1 foot, the whole should be cut together and issued green to horses, mules, bullocks, pigs or milch cattle. If allowed to grow higher, the grass will suffer owing to the excessive heat and want of ventilation caused by the *juar*. Both crops will shortly reappear and should be again cut at the same height. The third crop will contain very little *juar*. About six cuttings are obtained during the year, with a total outturn of from 600 to 800 maunds. Land thus trenched with cantonment night-soil will require re-manuring after five years, while land similarly treated with city night-soil will last fully seven years. If necessary, and especially where the space available for trenching is limited, the ground can be treated every second or third year.

vantages.

The system of surface disposal enables about seven times as large an area of land to be manured, as could be done under the deep trench system, with the same quantity of manure. Such land rents readily at from Rs. 20 to Rs. 45 per acre, and this means that it is possible to raise the revenue of cantonments under this heading very considerably.

pid de- mposition.

Rapid decomposition in the shallow trench system is due to the excreta being exposed (with a protection of only 3 inches of earth) to the action of the sun and atmosphere. Considerably less than 3 inches of earth would suffice to keep down the smell, but as such trenching is usually carried out on very poor or barren land with, little or no depth of soil, it is beneficial to the land to have 3 inches over the manure thus adding to the depth of the soil.

Ravine land six years after reclamation, *gátha-bandied* and planted with trees. There was formerly a very deep ravine running through this area, and the sides were cut away yearly by the flood water. By means of gatha banding, and banding, it has become almost level and produces excellent crops of grass annually.

(See Plate 2).

The cost of this system of manuring cannot be fully calculated, as the cantonment night-soil is usually obtainable free. The only expenditure to be incurred would be as follows :—

	Rs.	*a.*	*p.*
Extra remuneration to cantonment conservancy establishment,— including overseer, per acre	30	0	0
Seed, per acre	0	6	0
Labour for sowing and covering	12	0	0
Total	42	6	0

After many trials and experiments of the various methods of disposing of night-soil, from a sanitary point of view, the method here described has been found to answer best, while at the same time, from an agricultural point of view, it is far superior to the old methods of deep trenching.

CHAPTER XII.

Stock Manuring, Flooding with Sewage, Bone-dust, etc.

Stock manuring is the most economical method of manuring, but is perhaps more suitable for cereals than for grass cultivation. All the farm cattle are enclosed at night in a rough enclosure made of bamboos. The bamboos are tied to uprights made from loppings of *babúl* trees let into the ground. The rope used in fastening is *moonj* collected from the *sărpăt* grass before it flowers, thus avoiding the expense of purchasing rope. Condemned telegraph wire, if available, may be used instead of *moonj* and is more durable. The size of the enclosure is, of course, regulated according to the number of cattle to be enclosed; but as a rough guide one acre should hold 100 cattle. The animals should be fed in the enclosure, and never leave it except for work or grazing.

Advantages of this method.

By this method the whole of the farm-yard manure is secured, including the dung, urine, and refuse fodder. If the farm animals were kept in stalls the whole of the urine, a very valuable constituent, would be lost, and also part of the dung which intermixes with the earthen flooring, while the refuse fodder is usually thrown away or burned to avoid labour and carting. But by enclosing cattle, labour in collecting, carting, and spreading manure is saved; the animals being free in the enclosure, their droppings are scattered over the surface without artificial means. Another system of stock manuring is to picket the animals on the land and shift them daily. The enclosure is, however, much the better method, and is more beneficial for the animals, as they get more freedom. Each day's droppings should be covered up with earth by means of a *phaura* or hoe, so as to prevent excessive evaporation from the sun, and loss during stormy weather. This precaution is also necessary to prevent the dung being collected for fuel.

When to change the enclosures.

Fresh enclosures should be made every ten days, this being considered enough time to thoroughly manure each enclosure. The land manured should then be ploughed once lightly for grass cultivation, but if intended for crops it should be given many ploughings to thoroughly intermix the manure with the soil. Even on barren land wonderful results can be obtained by the introduction of stock manuring; and land so treated should not require to be either ploughed or manured for four years, while two crops annually may be expected, aggregating 300 maunds of grass per acre.

Cost of fencing.

Where bamboos and trees are grown on the farm the initial cost of fencing will be very trifling, and when the timber has to be purchased in the market, the expense on an enclosure large enough to contain 200 animals, should not exceed Rs. 100. The fence is readily shifted and will last a very long time.

Flooding with Sewage.

Large quantities of this valuable manure are available in the neighbourhood of all cities, more especially in those which have water-works. The sewage is usually

wage very luable as a nure.

wasted, by being drained off into rivers and canals, because the cultivators are either ignorant of its enormous value or fear the small expenditure necessary to lift it on to their lands. City sewage is largely composed of water used in flooding drains, urine, ashes, blood from slaughter-houses, and vegetable refuse from the drains. The land should be prepared in the same manner as for trenching with night-soil, but of course the length of the shallow-trench should be increased sufficiently to contain the day's sewage.

ow to lift it om the sewer.

The sewage can be lifted from the main sewer on to the adjacent land or into channels connecting the land to be manured with the main sewer. The lifting can either be done by hand or bullock-power pumps, which are not very costly, or by the Indian method with *dooglas*. This method of manuring is perfectly harmless, provided it is properly carried out, as has been conclusively proved in the case of night-soil. It is, in fact, a far more satisfactory sanitary method of disposing of the sewage than by allowing it to pollute rivers, and it is invaluable as a manure.

nglish methods.

A less expensive method of disposing of sewage is to plough and then flood the land intended to receive it. When sufficiently dry, a second ploughing should be made. In most of the sewage farms in Great Britain, it is, however, considered sufficient to allow the sewage to flow over the land from field to field until the effluent water passes off quite clear. It is a great pity, indeed,—to say nothing of the loss entailed—to see such a large quantity of sewage in Indian cities run to waste. In only a few cities, of which Amritsar is a bright example, is the full benefit of the sewage secured by its application to the land.

This form of manuring enriches and irrigates the land and thus green grass can be obtained throughout the year. It would no doubt give an outturn per acre of fully 1,000 maunds with three floodings yearly. The expense, with sewage free, would amount to—

	Rs.
Trenching per acre	12
Lifting the sewage	10
Total per acre	22

Flooding with ewage.

This sewage consists chiefly of water with an admixture of urine, cow-dung and refuse grains. No trenching is necessary, but the land should first be ploughed, and then flooded. Two or three floodings in one year are sufficient to convert the most barren into rich arable land, fit for any kind of grass or vegetables. It should be repeatedly ploughed, and when sufficiently dry, levelled with the *páhatá* to prevent excessive evaporation.

Burning, Bone-dust, and Residue of Tanks.

When burning hould be ractised.

The burning of jungle or trees is also beneficial to the land when done judiciously. The burnt vegetable matter lies on the ground and acts as a light dressing of manure. After the harvest season, when the hay has all been removed, the stumps of the grass, especially when long, as in the case of machine cutting, together with the aftermath, may, with advantage, be burnt. It thus clears away the stumps enabling the roots to send up fresh shoots, and results in a better outturn. In some cantonments the land is overgrown with *láphá* grass. This is a very fine and inferior variety, growing to a height of from 1 foot to 2½ feet, with very narrow leaves, and a flower composed of numerous fine spears, the heads of which are the real seeds of the grass. If allowed to grow to seed, it will spread very quickly, but it can be very successfully eradicated by burning, while the soil will at the same time be benefited. Burning is also advisable in cases where lands have deteriorated owing to neglect, and where some inferior grasses have been found to oust superior ones. Burning in such a case prevents the excessive growth of the inferior grasses, while it gives the superior grasses an opportunity of outgrowing them. If the growth of the inferior grasses be afterwards kept down, the superior grasses will in time oust them.

Photo-Block.

1902.

An exhausted brick field reclaimed by the banding and gátha banding system. The excavations varied from 5 to 8 feet in depth, and after a little expense in levelling and manuring, the land continues to produce two crops yearly (a *khárif* and *rabi* crop) similar to that shown in the plate.

Burning should never be resorted to where the grasses, though yielding only a light crop, are of good quality. Nor should cultivated grass lands ever be burnt. Leaves, refuse, etc., are frequently burnt and the ashes applied as manure. It is far better, however, to apply the leaves and refuse in their green state. Where grass lands have deteriorated by the growth of inferior grasses, one great precaution has evidently been neglected, and that is, the cutting of the grass crop before it has seeded. If the grass crop is cut in time before the seed ripens, there will be less risk of the lands deteriorating.

Bone-dust is not suitable for grass cultivation. It is a good manure for crops, but the cost of collecting, grinding, etc., is prohibitive. Bone-dust.

Warping is the removal of the residue from tanks and low-lying ground on to the land. It is really a rich silt composed of fish excrement, decayed vegetable matter, etc. Warping.

Being a quick-acting manure, it is best suited for crops, but should not be used if other manure is available as it is too expensive. After the tank is emptied, the bottom, to a depth of 1½ feet, is removed in baskets, spread on the land, and ploughed in. It is useful in loosening a stiff-clay soil.

CHAPTER XIII.

The Cropping and Issue of Green Grass.

The Cropping of Grass.

As the outturn of grass land largely depends upon the judgment exercised regarding the correct season for cutting the crops, it is a matter requiring the most vigilant attention. It has been already shown in the chapter on manuring, that manured land will produce an outturn of 800 maunds per acre without irrigation, in eight cuttings; but this is dependent on strict adherence to the rules on "Harvesting." Instances have been known, where similar land, owing to carelessness in the observance of the rules, has produced less cuttings and a considerably inferior outturn, both in quantity and quality. It is therefore incumbent to thoroughly understand when crops should be harvested, and how to apply the most advantageous method of harvesting. The first crop on manured land is generally fit for cutting at from 10 to 15 days after the commencement of the monsoon. The height of the crop at this period will probably be from 9 inches to 12 inches. It is not advisable to allow it to grow longer than this for the following reasons:—

Reasons for early cropping.

(*a*) The grass to the height of 4 inches from the ground becomes discoloured owing to the fermentation from below, and in this state it is somewhat unpalatable.

(*b*) By harvesting at the right time the grasses which have either not germinated or are still weakly are given a chance of sprouting, and thus a thicker growth is secured in the next cutting.

(*c*) If allowed to grow too long, the growth of weeds which usually spring up with the grass is not checked.

Season's cropping.

In a season of ordinary rainfall, the second crop will be ready about two weeks after the first cutting, while the third would probably be ready about three weeks later. The fifth crop is usually cut about the end of October, and is reserved (the season being suitable) for hay-making. This is the only crop on such land that should be allowed to attain its full height (from 3 feet to 4 feet high of mixed grasses, or about 2 feet high if *dub*). It is possible to obtain two or three good crops even after the hay crop has been harvested, between November and February. These are assisted greatly by heavy falls of dew; but when attacks of frost are frequent it is not always possible. All these cuttings should be made with the *jhabau*, (see plate No. 24), for reasons explained further on. From February to the commencement of the rains, at least two more crops will be obtainable. These latter will vary from 3 inches to 6 inches, and should be cut with the *khurpa*. (See plate No. 24.)

Reason for frequent cutting of the grass.

Frequently, through a mistaken idea, grass on manured land, after perhaps one cutting, is left to grow for hay-making. The idea is that a better outturn is

obtained in one cutting than would be obtainable from the method here advocated. This is erroneous, as it will be found that by the approach of the hay season the grass will have flowered, seeded, and partially rotted, and become totally unfit for consumption. By this latter system, too, an outturn of 300 maunds only per acre will be as much as can be expected. Another reason for frequent cutting is that it causes the grasses to grow thickly and with more leaf and finer stems, and consequently much superior hay is secured. If the grass were left entirely for hay without any previous cutting, it would, on richly manured land, grow to a height of 5 to 6 feet; but the stems would be thick and coarse with little foliage, and there would be an abundance of weeds in the crop. Such fodder would have to be chaffed before issue, otherwise complaints would be numerous. Frequent cutting is also valuable for keeping back the hay crop till dry weather when hay-making can be conveniently carried on. Grass, especially on manured land, grows so quickly that, unless frequently cut, it would seed long before the termination of the rains, and at a time when it would be impossible to manufacture hay.

Unmanured land to be cropped once only.

Unmanured land is only capable of producing one good crop and no attempt should be made to obtain two cuttings as the outturn would be less than if the land were only cropped once. There are of course many instances, especially in a favourable rainy season, where two crops can be reaped off unmanured land, with advantage. If the crop is not at its full height by about the commencement of August, it would be unwise to cut a second crop, as it would not have time to grow sufficiently thick and high by the hay-making season, or, say, early in October. In obtaining two crops off such land, it is essential to guard against drought, for, should no rain fall after the cutting of the first crop, little or no grass can be expected at the second cutting.

When to cut grass.

—As a rule all grass should be harvested before it seeds, whether for consumption in its green state, for silage, or for hay. There is no difficulty regarding the first two cases, which are not dependent on the weather; but in the case of hay great care must be exercised in selecting the time for cutting, as nothing can do more damage to hay than rain. The proper time for cutting is when the pollen can be readily shaken off the flowers or before the seed begins to ripen. At this period the grass is most succulent and nutritious and its foliage is green and tender. Where, however, the grass has been grown from seed, the matter is simplified, as the whole of the crop will mature about the same time; but on permanent pasture land, as in India, the crop is produced from old roots. Consequently it flowers quickly, and in cases where only one crop is obtainable (for hay), it is extremely difficult to cut it before it becomes over-mature. Hence the importance of putting the grass back by repeated cuttings, which is only possible on cultivated grass lands. No hard and fast rules regarding the cutting season for hay can be laid down, and the farmer must exercise his own judgment. In some cases, owing to there being no horned cattle dependent on the farm for fodder, and owing to there being more grass during the rains than is required for the feed of horses, the grass is not cut as often as is desirable. This should be avoided, and the grass should be cut and sold unless it can be siloed for issue to horned cattle in the dry season, or made into hay if the weather permits.

Cutting and Issuing of Green Grass.

Advantages of cutting and issuing green grass.

The success of a farm from a financial point of view mainly depends on the method of cutting and issuing grass in its green state. It is economical to continue to issue as much green grass as possible throughout the year. Whenever the grass is too dry it is more suitable for hay and the green grass issue should then cease. The advantages of this system are many:—

(*a*) the expense incurred in cutting the extra quantity is avoided, as is also the cost of manufacturing, stacking and protecting, while the risk of loss from fire is also avoided;

(*b*) the loss by deterioration which would be incurred by retaining the crop for hay only is avoided; and

(*c*) lastly, and not the least important, is that all animals thrive better on green fodder.

Photo-Block. Survey of India Offices, Calcutta, 1902.

The *Karáh*.

The cropping and issue of green grass.

Objections answered.

It may, however, be urged that green grass is not always suitable for issue, as it purges the animals. This argument is, however, untenable as regards animals doing slow work, while slight purging before or during the hot weather tends to keep down skin diseases and to improve the condition of all animals. This is fully realised in the Silladar Cavalry, where the animals are very largely fed on green grass, and where the percentage of skin diseases is far less than in British corps. In many stations, where grass farms exist, hay is generally issued throughout the year, and very little, if any, green grass. Instances have been recorded where Officers Commanding corps, on transfer from these stations to places where grass farms chiefly issue green grass, have readily accepted the ration, and have been pleased to notice the good effects produced. After all, green grass is the natural food of horses and cattle. At Allahabad the horses of both British and Native Mounted corps have during the last 19 years been fed almost entirely for seven months of the year on green grass, with the very best results. While the fresh crop of grass, which is somewhat young and watery, is being issued, it is advisable to issue a few pounds of hay to each horse to avoid any chance of excessive purging, but as the grass ripens, this can be discontinued.

Green grass to be issued fresh.

All grass should be issued on the same day that it is cut to avoid loss by dryage. That is, if grass is cut during the day it should be weighed in the afternoon at any convenient hour. Sometimes Commanding Officers demand the weighment of grass the day after it is cut. This could not be done without serious loss, as in this country fermentation is rapid, and the grass would have decreased about 50 per cent. in weight owing to the evaporation and fermentation of its natural moisture. The regulation lays down that grass containing its natural moisture should be issued as "green." Green grass generally contains 70 to 80 per cent. moisture, while hay has from 14 to 17. When, however, grass is issued in a *wet* state owing to rain, some extra weight should be allowed in the issue, to make up for the weight of water actually adhering to the stems and foliage. All grass cut for issue between the commencement of the rains and the end of October should be cut with the *jhabau*, and the *khurpa* only used when the grass is too short to be cut with the *jhabau*.

Mowing machines should be used only for the hay crop.

With the exception of the hay crop, it is not advantageous to use mowing machines in cutting other grass crops off manured land ; for where mowers have been used, the number of cuttings were considerably less than is obtainable with the use of the *jhabau*. In the case of British Mounted corps, when grass-cutters are not employed, hired men should be entertained, at about 8 rupees per mensem, to cut the daily grass requirements of the corps. A daily task should be fixed according to the quantity of grass an ordinary labourer could cut during a day and the wages of the grass-cutters should depend on their cutting this quantity. Each man should cut 8 maunds daily from the commencement of the harvest season to about the middle of October. During this period, hired labour can be obtained to cut grass at 6 pies per maund, which is equivalent to 8 rupees a month at 8 maunds daily. From the middle of October, or after the hay crop, when the grass is nearly dry, till the end of December, he should cut 4 maunds a day. From this period until the commencement of the rains, the quantity to be expected would vary from 3 to 1 maund daily, and is obtained by using the *khurpa*. The object of keeping monthly-paid grass-cutters for this special work is to obviate unnecessary trouble of checking the labour employed, and to avoid all chances of peculation on the part of the native subordinates engaged, both in delivering and receiving the fodder. If provided with mule or other carriage, these permanent grass-cutters should bring their day's cutting to the place of weighment for check.

System of cutting.

Under the old grass-cutter system, a grass-cutter was maintained at Rs. 4 for each horse. That is to say, in the rains he had to bring in 46 pounds of grass only! Under the grass farm arrangements one grass-cutter at this season cuts sufficient grass for 14 horses! Of course the difference is not so marked in the dry season. On farms which are worked conjointly for the whole of the Government animals in the station, it will not be necessary to keep many hired labourers for cutting grass, as the syces necessarily kept up for the Native Cavalry under the Silladar system should be utilised during the rainy season to cut fodder for all the animals in the station.

CHAPTER XIV.

Ensilage.

Defined.

ENSILAGE is the process of storing green grass or other green fodder in pits. The SILO is the pit in which it is stored. SILAGE is the name applied to the contents of the SILO or pit when preserved.

Ensilage was first largely practised in America, and of late years it has been largely adopted all over the world. Since 1882 extensive experiments have been carried out in India, especially at Allahabad where, perhaps, the silage operations have been on the largest scale of any, some 700 pits of various dimensions having been made in 18 years.

Object.

The principal object of ensilage is to preserve fodder in a plentiful season for consumption during seasons of drought. It is specially valuable in India, where grass grows plentifully during the monsoon, and if not disposed of, rots quickly, as it cannot at this season be converted into hay; while the fodder thus obtained is consumed during the hot weather, when grass practically does not grow at all and when succulent fodder is of the greatest value.

Time for manufacturing silage.

Silage can be manufactured at any time while the grass is green and is not interfered with by rain falling at the time of filling the pits. Almost all kinds of weeds, which in their green state would be refused by cattle, make excellent silage. When grass is ripe and somewhat dry, it does not make good silage, and should therefore be kept for hay. Grass obtained off newly-manured land does not make very good silage if pitted straight away. It should therefore be allowed to lie in bundles outside the pit for at least 12 hours before being pitted. This produces a partial fermentation and dryage of the excessive moisture in the grass which is the cause of failure.

Advantages.

The outlay on the manufacture of silage is far less than that incurred in hay making, while there is no risk of fire, and less loss in weight by conversion. It is the only economical means of disposing of weeds by rendering them edible and thus saving the expense of removing them from the land.

Implements to be used in cutting the grass.

All grass for silage should be cut by contract, not through any middleman, but direct with the grass-cutters. The usual rate paid for grass, delivered and weighed into the pits, is 6 pies per maund. This rate should hold good for grass cut within a radius of half a mile from the pit. The grass must be cut with either the *jhabau* or the *hassia;* but if the latter implement is used, care should be taken to see that the grass is cut close to the ground to avoid unnecessary wastage. On no account should the *khurpa* be used, as earth is unavoidably mixed with the grass, which results in cattle refusing the silage on account of its grittiness. It is also undesirable to cut grass for silage by mowing machines, for reasons explained in the chapter on machinery, as well as on account of the extra expenditure that would be incurred in collecting binding, carrying and pitting the grass.

Sites for pits.

The first step in the process is to select the site for the pit. The spot chosen should be as near as possible to the centre of the area to be cut, so as to avoid unnecessary carriage of the grass to the pit. The site should be on rising ground, or if the ground be very level, on places where water does not lodge during heavy rain. Further, it should be at a distance from barracks and bungalows and to the leeward side of them with regard to the direction of the prevailing winds. It would perhaps be advisable not to cart the silage through the inhabited portion of cantonments. These precautions are suggested with a view to avoid complaints regarding the smell which, although pronounced by the highest medical and sanitary authorities as wholesome, is sometimes far from pleasant, especially in the case of the sour variety of silage.

Dimensions of pits.

The dimensions of the pits are matters which depend upon the following circumstances. Pits or silos should be made only to contain so much green grass as, when converted into silage, will feed the whole stock required to be fed on it for not more

Photo-Block. Survey of India Offices, Calcutta, 1902.

Illustrating a quick method of making irrigation beds.

Ensilage.

han eight days. If silage be exposed for a longer period, the loss by dryage will be great nd the cattle will not eat it so readily. Silage is also peculiarly susceptible to deterioation if wet by rainfall, and cattle will in this state frequently refuse to eat it. On he other hand, the pit should not be too small or contain less than four days' fodder. A few large pits are preferable to a number of small ones, because more land is wasted n the case of the small pits, and the expense incurred in covering, opening and filling p the crevices, etc., is increased. A pit 30 feet long by 12 feet wide and 6 feet deep, r of 2,160 cubic feet capacity, will contain 1,500 maunds of green grass, which when onverted will turn out 1,000 maunds of silage. This has been found to be a very onvenient size for a pit, and the cost of digging one at Allahabad is Rs. 3-14-0. The epth should be the same for all sized pits, *viz.*, from 6 to 8 feet. If deeper than this n land where water is near the surface, the moisture will be excessive. The above nethod is a convenient one for covering, as the *beldars* can easily throw the covering arth with the *phaura*. The length of the pit, of course, varies with the quantity of rass to be siloed.

How to fill silos.

The earth excavated is thrown around the pit, 2 feet clear of the edge to avoid its falling in again and mixing with the fodder. After the cutting for the day is finished, grass cutters then tie the grass into bundles as near as possible one maund each. These bundles are collected round the pit ready to be weighed and pitted. The overseer hen selects a bundle from each man's cutting, weighs it and allows the weight as the verage of his tale. This, though rough and ready, is fairly accurate, and it avoids he necessity of weighing each bundle. Frequently on large farms over 2,000 maunds f grass are cut daily for silage, which quantity it would be impossible to weigh in ime. Spring balances are used for weighing. After weighment the grass-cutters hemselves toss their bundles into the pit indiscriminately. The grass is piled up bove the surface to a height at least equal to the depth of the pit. This is to ensure he contents of the pit not subsiding below the surface after the covering of earth is pplied. If a less quantity of grass were put in, or if the pit were merely filled to he surface before being pressed, the contents and the covering of earth would sink elow the surface and a depression would be formed through which water could easily nter the pit and destroy the silage.

How to cover up the pit.

After piling the grass up carefully, the covering of earth should be applied by first commencing to cover with the earth nearest the edges of the pit. This earth should be heaped against the sides so as to form a buttress against the piled up grass which will prevent its bulging over the edge of the pit when pressure is applied from above. This buttress forms the base of the covering, and must extend at least 3 feet outward from the edge of the pit all round so as to make the pit air and water-tight. The earth is then piled on top of the heap of grass, which will rapidly sink under the weight. The weight of the excavated earth will give ample pressure without the necessity of digging extra earth or applying other extraneous pressure. If excessive pressure is applied, especially in the case of young and succulent grasses, the silage will be inferior. When covered, the slope should be similar to that of the roof of a house, to ensure no water lodging on it or penetrating the covering, and should extend from the ridge to a distance of 3 feet from the edge of the pit. All depressions in the ground in the immediate neighbourhood of the pit should be filled up to prevent water lodging in them and percolating into the silo. This precaution is especially necessary on black-cotton soil.

The cost of covering a pit of these dimensions is—

	Rs.	*a.*	*p.*
10 *beldars* at 2½ annas	1	9	0
5 coolies „ 1½ „	0	7	6
Total .	2	0	6

Having covered the pit, it now only remains to ensure its remaining thoroughly air and water-tight. The contents will continue to subside for months, and, as they do so, fissures will appear in the covering. These should be immediately closed to keep out the air and water.

Ensilage.

When to open silos.

If the above instructions are carefully attended to, the silage will remain good in the pits for an indefinite number of years. It has been ascertained by experiment that the contents of two pits opened after eight years were as good as if they had only been stored a year. The process of converting green fodder into silage occupies about 60 days; but as silage is usually pitted about August, it is advisable not to open the pits before January or February, or better still in April or May, when other green fodder is scarce.

Masonry silos not necessary.

Kacha pits, that is to say, those merely dug in the ground, are preferable to those lined with masonry, as the water which must necessarily oe exuded from the grasses, and any percolation from above, is absorbed by the soil. Masonry pits have been tried at Allahabad, but with but little success, for when opened they usually contained from 1 to 2 feet of water at the bottom, while half the contents of the pit was unfit for fodder. The earthen pits, moreover, are far cheaper, and can be used repeatedly.

In places where water is near the surface, pits should, if possible, be above ground, in which case the sides may be of masonry. The necessity for this is apparent, as if dug below the depth at which moisture is found, the earth would not absorb the excess moisture from the contents.

At Allahabad experiments have been tried with silos of the following shapes:—

Circular.
Rectangular with perpendicular sides.
„ „ sloping sides.
In stacks above ground.
With masonry sides above ground.
With all masonry under ground.

Different methods of siloing.

These pits were filled by various methods besides that recommended above, some of which are described below:—

(*a*) The SLOW FILLING SYSTEM.—Under this process of siloing small quantities of grass are dealt with daily, thus extending the operation over a lengthy period and allowing the grass to ferment thoroughly before adding a fresh layer, and the temperature was daily taken by the insertion of a thermometer. The grass was spread by hand labour, and subsequently trampled by coolies, bullocks, or elephants at the close of each day's work. At night, pressure was applied by laying *bullies* (or poles,) across the top, and placing iron shot, 24-pounders, over them. Kerosine oil tins filled with sand were also used. On the following day the pressure was removed and the filling process again continued, and repeated until the pit was filled. The pits were then covered over in the usual way. This system was supposed to produce sweet silage and was carried out for three years in succession until the present system, described above, was introduced, with far superior results and at very much reduced expenditure. Both Professor Wallace and Dr. Voelcker assert that the quicker the silos are filled and covered, the better the results. Their opinion is fully confirmed by experience gained in India. In places where farming operations are extensive, it is possible to fill a pit one day and to cover it the next.

(*b*) The STACK SYSTEM.—The stack system of ensilage is an expensive one and quite unsuited to India. It is briefly as follows:—The grass is heaped up in layers, and pressure applied by Johnston's patent, or other artificial means. Ladders are necessary as the pressure has to be removed in the day time and applied at night; the labour required is excessive; while damage may occur through the heat of the sun or by a heavy fall of rain. This system was experimented on by the late Sir Herbert Macpherson, but the results did not warrant its continuance.

It may be taken as an axiom in the process of ensilage that, the younger and greener the grass, the more objectionable will be the smell. Strange to say, however, the cattle prefer the stronger smelling silage. More mature grass produces sweet silage of a brown colour.

Photo-Block.

Survey of India Offices, Calcutta, 1902.

The *dugla* or basket water-lift. Two men working at a time.

Bad silage is readily detected by its odour, which resembles that of rotten cow-dung. Its inferiority can be traced to one of the following causes :— Causes of bad silage and the remedy to apply.

(*a*) Immature and rank grasses obtained off manured land, to which too much pressure has been applied.

(*b*) Insufficient pressure.

(*c*) Neglect to fill up the fissures which appear on top as the contents sink.

Bad silage should be disposed of as manure.

The total loss of silage in a pit of the size and dimensions advocated should not, if carefully attended to, exceed 2 maunds per pit. This loss represents the quantity of silage unfit for issue, and does not include the loss by conversion of green grass into silage, which, as previously stated, varies from 30 to 35 per cent. Some small loss is unavoidable where the silage touches the sides, bottom and covering of the pit.

All crops, such as *sorghum*, maize, oats, barley, wheat, guinea grass, and even weeds make excellent silage. Where steam-power is available, these crops could be chaffed prior to pitting, thus admitting of a greater quantity being got into the pit. The chaff spreads evenly, presses compactly, and is eaten very greedily by horned cattle.

CHAPTER XV.

Hay and How to make it.

Hay and dry grass are often used in India as synonymous terms. HAY is the name given to grass dried, cured and fermented in stacks. Green grass merely dried and not subjected to fermentation in the stack cannot rightly be termed hay, though it frequently passes as such in India. It is extremely difficult in this country to make good hay for the following reasons :— Hay defined.

(1) The long, and in many places, heavy monsoons.

(2) The coarseness of most Indian grasses.

(3) The difficulty of obtaining sufficient labour at harvest time in consequence of the natives being engaged in cutting their own crops.

Good hay will have the following characteristics :—

(*a*) It should be free from dirt. Characteristics of good hay.

(*b*) It should be well preserved.

(*c*) It should be of a fine green colour.

(*d*) It should have a sweet smell.

(*e*) It should be composed of fine, richly-cultivated grasses.

A number of the above are dependent on the grass having been cut at the right time, *i. e.*, when the bulk of the grasses are in flower, before the pollen can be freely shaken from the flower and the nutrient ingredients in the stem migrate upwards to aid in maturing the seed. In India this is difficult, where the crop consists of mixed grasses including the monsoon grasses which flower early. In order to guard against early maturity, it is essential to put the crop back by repeated cuttings as described on page 25, Chapter XIII.

During breaks in the monsoon it is possible to make hay on a small scale, but the risk of damage by sudden change in the weather renders the experiment hazardous : and if it succeeds, the hay must be stored in a dry shed, or else the moisture from the ground during the monsoon will penetrate upwards into the small stack and damage the hay. It is therefore advisable not to commence hay-making operations till there is good reason to expect that there will be no more *heavy* rain. If grass is exposed to heavy rain after being cut, it is rendered almost useless for any other purpose than bedding. Late cutting will no doubt injure grass, but not nearly to such an extent as when washed by heavy rain after it has been cut. This is due to the waxy matter which covers the stems being washed off and the water penetrating the grass and washing out some of its soluble ingredients. Hay subjected to rain in this manner is inodorous, dark and discoloured, and weighs light. Hay-making during the monsoon hazardous.

Hay and how to make it.

Implements to be used in cutting grass for hay.

The grass intended for hay-making should be cut with the mowing machine, the scythe, the *jhabau*, *hassia* or *daranti*. With these implements there is no fear of dirt being introduced into the hay. In cutting with the *hassia* or *daranti* care should be taken to cut low, for, being usually the last crop off the land, every endeavour should be made to leave little but the roots. This is not always possible, and therefore only under unavoidable circumstances should these implements be used. If bullocks are supplied free by the Supply and Transport Department, it is an economical method to use the mowing machine in cutting the hay crop off unmanured land. Grass cut by machines makes good clean hay, and as it falls from the mower in swaths, it can be easily spread out and quickly dried. On a large farm it would be impossible to cut the crop in proper time without the aid of mowers, owing to the labourers being then engaged in harvesting their own crops. In places, however, where the grass crop is under a foot high, the *khurpa* should be used. If cut with any other implement, large quantities of grass will be left on the land. Although it will not be possible to cut the grass quite clean with the *khurpa*, still the quantity of earth can be reduced to a minimum by reducing the wages of the grass-cutters according to the quantity of earth found with the grass. Another objection to the *khurpa* which should be guarded against, is that the grass-cutters dig up the roots or tufts of grass with the object of increasing the weight. When the grass is so short as to require its being cut with the *khurpa*, the best system of payment for cutting is by weight, and where it is sufficiently high to be cut by other implements it is economical to cut by piece-work. In fact, as far as possible, all grass crops for hay-making should be cut by piece-work, or what is commonly termed the plot system. Contracts are entered into with the grass-cutters (not with any middleman) to cut a certain area within a specified time. It is very important to limit the men to time, otherwise they may delay and allow the grass to become over-ripe. An agreement in the following terms should, therefore, be formally signed by them :—

"We, the undersigned, do contract to cut the grass off————plot of land, cutting it close to the ground, and to do so within————days for Rs.————. In case of failure to complete the work within the specified time, or cut the area close to the ground, we agree to forfeit one-third of the amount contracted for."

Cost of cutting the grass.

On all farms the land should be divided into sections or plots, and the areas of each should be entered in the maps and field books. In determining the amount to be paid for cutting any plot, it is necessary to consider the quality of the grass (coarse or fine), and its thickness of growth. In the case of two plots of the same area, with variations in the quality and thickness of the grass, the heavier crops would justify a higher rate than the poorer one. The rate for cutting varies from Re. 1-8 to Re. 1-12 per *bigah* (or from Rs. 2-8 to Rs. 3-2 per acre) according to the coarseness or fineness of the grass making it easier or more difficult to cut. The plot contract system is easily susceptible of being checked by the farm map and field book, which should show the areas of the various plots enclosed by the *gáthá bándi* system. In this method, the only supervision necessary is to ensure the crop being cut as near to the ground as possible—a point which the grass-cutters are apt to ignore, as it entails slightly more labour.

Mode of saving the grass.

The grass is allowed to lie on the ground in swaths as it is cut. These swaths should be opened and exposed to the action of the sun and atmosphere. The grass can also be dried by the use of the tedding machine, without hand labour. Another method frequently adopted in cutting grass for hay is by weight, the grass is cut during the day, tied into bundles in the afternoon, and collected in one place for weighment, after which it is allowed to remain in the bundles till next morning when coolies are entertained to open the bundles and spread the grass for drying. It is a great mistake to suppose that the more hay is tossed about, the better it is cured. If knocked about too much the result will be a loss of foliage, and injury to the colour and odour of the grass. The cost of hay-making by this method is excessive ; it takes longer to cure the hay ; and its quality is inferior to that made by the plot system or when grass is cut by machinery. The cost of cutting the grass is also higher than in the plot system.

Comparison of plot and weighment systems.

From the following comparison of the cost of making hay by both methods, *viz.*, by the Plot and WEIGHMENT SYSTEMS, the advantages of the former are at once apparent.

Photo Block. Survey of India Offices, Calcutta, 1903.

An avenue of mangoe trees, 12 years old, in the Macpherson Park. These trees have been bearing fruit for the past three years.

Hay and how to make it.

Two acres of land yield a similar outturn of grass—say 150 maunds each—and are cut by both methods. The cost for the acre under the *plot system* would be :—

	Rs.	*a.*	*p.*
Cutting, per acre	3	2	0
5 Coolies for tossing the hay at 1½ anna each .	0	7	6
Total .	3	9	6

The cost by *weighment* :—

	Rs.	*a.*	*p.*
Cutting 150 maunds, @ 9 pies per maund (the usual rate for cutting grass for hay) . .	7	0	6
15 Coolies @1½ anna each for spreading the grass and making hay	1	6	6
Total .	8	7	0

It will thus be seen that the plot system is by far the more economical. But besides this, it saves much labour, for when grass is cut by weight, each grass-cutter's name and the quantity of grass cut by him have to be registered daily, and daily or weekly payments are made. The daily weighment of the grass also necessitates work being stopped early in the afternoon to admit of its being tied into bundles for weighment. In the plot system, the labourers cut by area, and are not paid until their work is completed. The weighment of the grass and the registration of names are dispensed with and the work goes on the whole day without interruption. Since time is valuable in hay-making, the plot system of cutting grass may without hesitation be pronounced the most advantageous in every respect.

The PULA or sheaf system of cutting grass for hay is in general use in many places. The grass is cut and tied into sheaves of a prescribed weight— so many to be cut per rupee. This system answers well enough with *bhir* or uncultivated grass, which contains considerably less moisture than cultivated grass. Where moisture is excessive in grasses, it would not be suitable owing to the risk of damage from excessive fermentation. Grass so cut can be saved well. The sheaves, or *pulas* are turned daily for two days, to admit of thorough exposure to the sun and wind. The more exposed portions of the sheaves become a little discoloured, while the inner portion remains green. The *pula* system.

It is impossible to make hay by contract, as contractors eager to swell their profits are certain to save expense in curing and cocking as well as to damage the hay by stacking it before it is properly cured. Where these operations are totally neglected, the grass is allowed to dry on the ground for several days after it has been cut, until it dries without ever being tossed. This system demands the presence of some responsible supervisor throughout the day. Many failures resulting in serious loss can be traced to contracts entered into with middlemen for ready-made hay. The hay is weighed before it is stacked, and the middleman (or contractor) is paid for the actual quantity weighed. This system is a direct encouragement to dishonesty, as it is so difficult to exercise check over it ; the middleman and the receiver being free to enter into a mutual understanding. If this system is inevitable, the contents of the stack should be arrived at by measurement in the manner described on page 38. But even this check can be disputed for the following reasons : the formula is only approximate and varies according to the length of time taken in making the stack, the interval since the stack was made, the coarseness or fineness of the grass, and the amount of moisture in the hay. Under no circumstances therefore should hay be cut and made by contract. Contract system deprecated. Causes of failure.

The Tedding and Cocking of Grass.

It is advisable not to commence cutting until the ground is sufficiently dry to admit of the hay being made without risk of damage from moisture below. Every endeavour should be made to make the hay quickly and to handle the grass as little as possible. It should be tossed with forks, made of forked branches of trees by the labourers The tedding of the grass.

Object of tedding.

themselves, or better still by the tedding machine. (See plate No. 28.) The object of tedding is to admit air and sun into the grass in order to dry it quickly, and to prevent too long an exposure of any part of it to the powerful rays of the sun at this season, which would detract from the colour of the hay. Grass cut by machinery needs three tossings in one day to dry it, while with the plot system of cutting, two will suffice. In the former case, the grass falls from the mowers in thick swaths which should be shaken or well-spread out, to admit of its drying quickly. Excessive tedding would result in most of the foliage dropping off the stems. Grass cut by weight requires to be tedded three or more times, in order to free it entirely from dust. The forward action of the tedding machine is best suited for this purpose.

In India it is possible to make hay in a single day. The grass is tedded throughout the day, and raked into rows by the horse-rake (see plate No. 29) in the afternoon. The raking should be done before 5 P.M., for later the grass will be injured by the dew, which begins to fall about this hour. Grass cut between early morning and noon should straightway be put into cocks containing from 10 to 12 maunds. The grass cut between noon and evening, which is not sufficiently dry to be cocked, should be either allowed to remain in rows or put into small heaps to avoid damage from dew. This grass is spread out again next morning for a short time as soon as the sun is well up and the ground dry, and it is again cocked. In some parts of England, hay drying machines are used, generally for sewage farm grass in which the moisture is very great, and it is not possible to dry it quickly by exposure. The use of such machines is not necessary in India.

Exposure to dew detrimental.

Cocking necessary.

The cocks should be erected on high and dry ground and if conically shaped, there will be no risk of damage from slight rain. The hay should remain in cocks from two to seven days or until a favourable opportunity offers for stacking it. This allows of a slight fermentation before stacking, and the dryage of any grass cocked in a moist state. Hay, or rather dry grass, is often stacked in India without cocking. The cut grass after lying on the ground three or four days without, perhaps, even being tedded, is collected and stacked straightway. This method, no doubt, results in a saving of labour in cocking and curing, but on the other hand the risk to which the hay is exposed by rain, dew, and excessive exposure to a hot sun is enormous. Grass preserved in this manner cannot rightly be termed hay, it being defective in colour, odour, and nutrient ingredients. Money saved in cocking and curing will not compensate for inferior hay. The hay should not remain longer than seven days in cocks unless the weather prevents its being stacked. If hay remains longer than seven days in cocks, it deteriorates on account of the rain, dew, excessive evaporation and damp from below, and the result is musty, woody hay of little value as fodder. Slight showers of rain do not damage hay in cocks to any great extent, and the cocks should not be spread out to dry as this exposes it to greater risk than need be apprehended from the rain. A day's exposure to the air and sun will dry the cocks quickly. In the case of heavy rain, when the cocks are saturated, the only alternative is to spread the hay out to dry, unless it can be issued straightway to cattle. Hay, however, once dried in this manner, cannot be of the best quality.

Fine hay should remain in cocks.

What has been said in this chapter will show that there is abundant room for skill in the operation of hay-making.

CHAPTER XVI.

The Stacking of Grass.

Site for stacks.

Stacking is necessary not merely for storage, but to admit of the dry grass being converted into hay after sweating. The site selected for the stack should be on *rising ground*, and the grass on the spot should be cut several days in advance to admit of the ground being thoroughly dried. As far as possible *dry weather* should be selected for stacking. No artificial platforms are necessary, the stacks being simply built on solid foundations. Nor is it necessary to put down a *layer of ashes*, which is frequently done to guard against white ants. Practical experience proves that white ants do not attack hay-stacks; indeed the pressure and heat in stacks, the size of those

Photo Elsee

Bamboo trees, 14 years old, in the Macpherson Park at Allahabad. These were planted as seedlings, and have been producing bamboos for the past seven years, which have been utilised for scaffolding, for cattle enclosures, and in the construction of buildings.

Stacking of grass.

usually made in India, is too great to admit the entry of either rats or insects. As in cocking and hay-making, every endeavour should be made to avoid damage from rain. Stacks should be erected, as far as possible, towards the centre of the field from which the grass has been cut.

Stacks should not be too near each other.

It is not advisable to have all the stacks on a farm collected into a stack-yard, because in case of fire there is danger of losing the whole hay crop: in fact, it is tantamount to "putting all your eggs into one basket." The carriage of the hay from the land to the yard is also extra expense, while there is considerable loss of hay in transit. The hay is likewise liable to deterioration by long exposure in carting and stacking. The only apparent advantage in having stack-yards is the saving of labour in protection.

The advantages gained by stacking on the land where the grass is cut are as follows:—

(1) Saving of time.
(2) No labour for carriage.
(3) No loss between the cock and the stack.
(4) Less risk from fire.

Employment of chowkidars.

It is necessary, however, in this case to employ three chowkidars, who will take turn about at sentry-go, for each stack, containing from 2,000 to 2,500 maunds of hay. The expenditure on this account is not so great as would appear at first sight, because these men, while protecting the stack, are also conserving the surrounding land and, in fact, two of them would be required to protect the land, irrespective of the stack. The case is not similar to that of the English farmer, who makes hay for his own animals, and therefore has to provide carriage to bring it to the farmyard, where it is to be consumed. A stack-yard would then perhaps be necessary, but in cantonment-farming the hay is issued to different corps located in various parts of the station, and carriage for delivery will be equally necessary whether the hay is stored in the stack-yard or in the fields.

How to make stacks.

Before making the base of your stack, it is necessary to make a rough estimate of the quantity of hay to be stacked, that is, the quantity that can be conveniently stacked without extra cartage. This is to avoid the necessity of entertaining carriage to bring hay from a distance to complete a stack which has been commenced on too large a scale, or, on the other hand, for carting away hay which is over and above the capacity of a stack commenced on too small a basis. A convenient base for a stack to contain from 2,000 to 2,500 maunds of hay is 60 feet × 20 feet. The rectangular shape is preferable to the circular for large stacks, being easier to build. An outline of the base is first made and the hay thrown on to it and piled up to a height of about 8 feet, care being taken to have the sides and ends perpendicular. This 8-feet depth will, of course, sink down as pressure is applied from above to about 1 foot, and from this height the grass should be laid on layer by layer, projecting over the sides and ends, until the stack has reached a height of 18 feet from the ground. Care must be taken not to increase the overlapping on the sides and ends too quickly, and, at the same time, that the centre and sides should be filled simultaneously, so that the trusses of hay may interlap, and bind. The hay should not be stacked in bundles, but should be opened out with hay-forks by the stackers and spread evenly. *Chootia*, or the commonest salt, has frequently been sprinkled over the layers of grass in the stack, especially when the grass has not been properly saved. The surface of the stack at this height should be about 70 feet by 30 feet, and from this point each successive layer laid in should narrow until the ridge is reached, that is, the upper portion is sloped off to either side in the same way as the roof of a house. A stack so built will, on completion, be found to measure 10 feet from the ground to the eaves, and thence to the ridge about 15 feet—a very suitable height for all purposes. The slope should be as steep as possible on both sides, so as to readily carry off any rain water. At both ends, the stack is built perpendicularly from the eaves to the ridge in order to make it more shapely. When stacks are properly finished, those which will be used before the next rainy season need not be thatched. Those kept throughout the rains should, however, be thatched.

Stacking of grass.

Small stacks not recommended.

The erection of small stacks containing about 1,000 to 1,500 maunds is frequently advocated on the grounds that there is less risk of loss from fire. This is a mistake, as a large stack is just as easily protected, while the loss from dryage occasioned by heat and warm westerly breezes and outer surface damage by exposure increases in proportion to the smallness of the stack. Owing to the excessive heat of the sun in India there is great loss from dryage by evaporation, and therefore within reasonable bounds the larger and higher the stack the less the damage. The object of sloping the sides so as to have the eaves projecting over the base is to shelter them and in the event of rain to allow the water to drop from the eaves direct to the ground. Stacks made with perpendicular sides and ends are very liable to damage by rain running off the eaves into the hay, and are therefore to be deprecated.

There is nothing that looks so ungainly as a badly shaped stack; while a well-shaped one is often even picturesque (plate 25). To secure this end, it is not difficult to "pull" a stack when completed—though this can be better done while it is in course of construction,—that is, all loose hay is "pulled" out to render the stack more presentable, and to guard against water getting under the stack, a shallow drain 1 foot wide and 6 inches deep, should be dug all round it—the outlet of the drain being at its lowest part.

The ramp.

Many machines for economising labour in stacking have been introduced, but in India, where labour is comparatively cheap, the ordinary bamboo "ramp" may be considered the most economical method for erecting stacks. It is commonly used throughout the country, especially in the construction of lofty buildings. From the ground up to a height of 12 feet, no ramp or machinery is necessary, as the coolies can easily ascend through a passage left in the side of the stack, or over a cart. Plate 25 shows a ramp in use. It is merely a large ladder consisting of *ballies* for uprights, long bamboos and tie-beams for the supports. It can be constructed by six men in one day, and the requisite material costs about Rs. 30. If this material is carefully stored away after use, it will last for many years, but it is cheaper to utilise it in the construction of buildings, etc., and to purchase new material yearly. The uprights are first fixed in the ground in pairs 10 feet apart and at intervals of 15 feet, receding from the stack, the strongest being nearest the stack. The tie-beams are next attached according to the slope required. Three rafters are then laid on the tie-beams, one in the middle of the proposed stairway and the others one at each side, and are lashed where the tie-beams and uprights meet. A gangway will thus be formed, with a flooring 8 feet wide, made up of sections of small bamboos lashed together. The sections are usually 3 feet wide while the length of the short bamboos will be about 10 feet, or rather wider than the gangway. These sections being disjointed, enable the ramp to be readily dismantled for transfer to another stack when required. As the coolies engaged in stacking are usually women and children, it is advisable to attach two long bamboos to the top of the uprights on each side, so as to form a railing. The width of 8 feet is necessary to allow of the coolies going up one side with their loads and coming down unladen on the other side. The ramp is erected at the centre of the stack, and as the hay is received, the stackers at each end arrange for its equal distribution. When it is necessary to raise the ramp, all that is needed is to open the lashing of the few highest uprights and tie-beams, and prize up the ground floor to the required height and slope, when the lashings are again tightened. When required it can be lowered in a similar manner. This ramp is readily re-erected and moved from stack to stack.

How to make a ramp.

Ladders have frequently been used for stacking, and are still used by those to whom the ramp is unknown; but they have been found unsuitable and expensive, as well as a much slower process, since only one bundle of hay at a time can be handed up.

Patent elevators not so economical.

Patent hay elevators and American lifters similarly are not nearly so suitable or economical as the ramps, except where manual labour is scarce. Where it is plentiful they are not so economical, as coolies have to be employed to bring the hay from the cocks to feed the elevator, and having come so far they might as well deposit their loads on the stack. With the ramp, on the other hand, the coolies bringing the hay merely walk a few yards further up the ramp and deposit their bundles on the stack. This has the further advantage of pressure derived from the coolies trampling on the

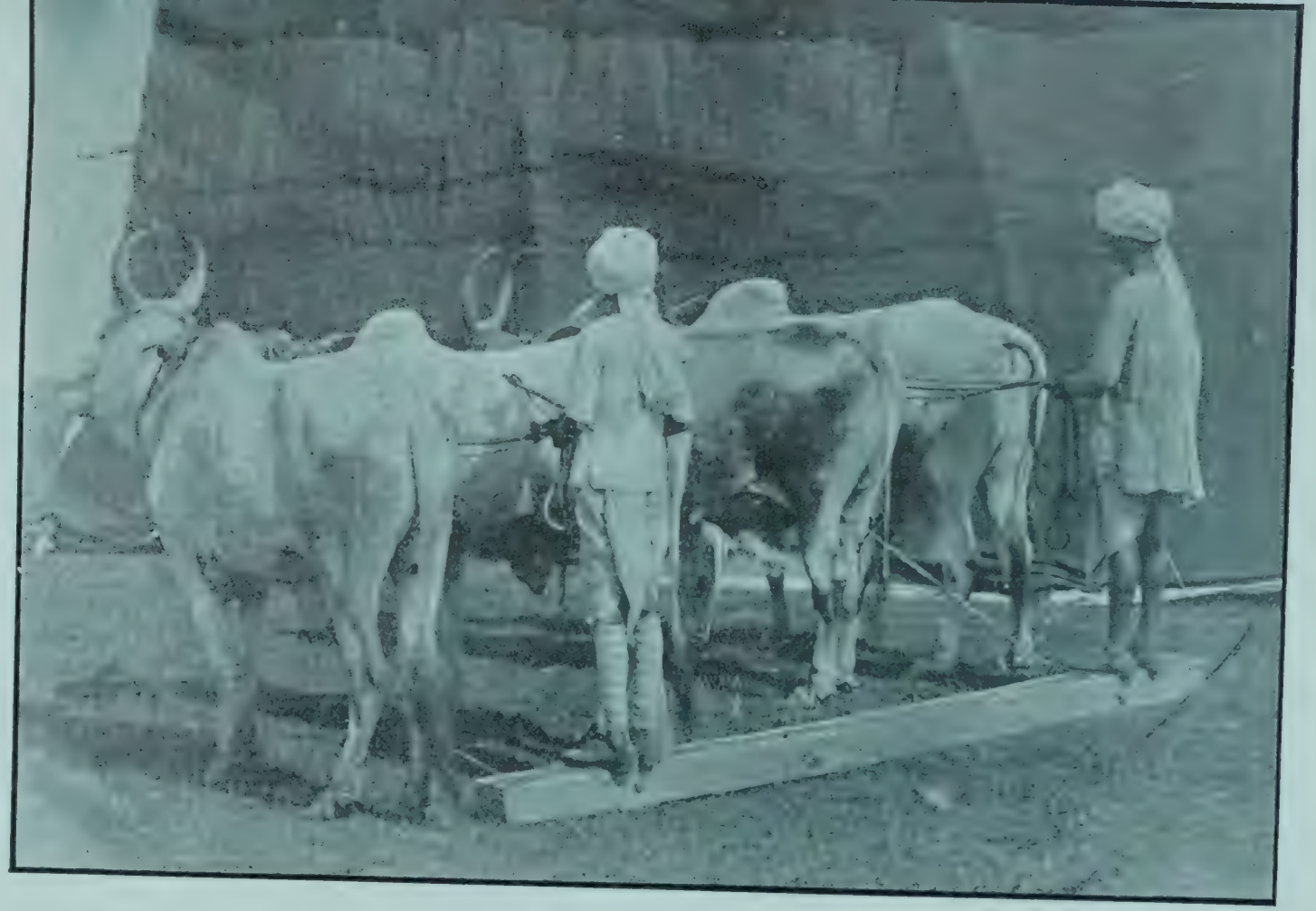


Photo Block

Survey of India Offices, Calcutta, 1903.

The *páhata* or wooden plank. The drivers stand on it to increase the pressure.

stack, which is conducive to greater density and neater stacking. These patent machines are liable to breakage, whereas any mishap to the ramp can be repaired in a few minutes. It might here be mentioned that the coolies carrying the bundles of hay to the stack use ropes for tying made of *moonj* gathered from the *sărpăt* grass which is to be found in most cantonments. Rope should not be given them, or the expense would be immensely increased.

Stackers.

The proportion of stackers to coolies is about one to ten, but of course will vary with the distance the hay has to be carried to the stack. Stackers should be trained men. It is an art acquired after considerable practice, and in order to encourage stackers, it is advisable to pay them 25 per cent. higher wages than ordinary labourers. They never handle the hay, but use hay-forks, in spreading and laying the hay on the stack. Stacking if well done should not cost more than 2 pies per maund, or Re. 1 per 100 maunds.

Use of tarpaulins unnecessary.

Rick cloths and tarpaulins are often advocated for sheltering hay from rain, but as these are expensive and not absolutely necessary, expenditure on them is money thrown away. If the stacks are made quickly and according to the instructions given above, there will be no need for either. Another system of thatching stacks is to use bamboo frames and thatch in the same manner that a house is thatched. This also is too expensive, as the thatch for a stack does not usually last more than a year. Thatching is only intended to afford protection during one rainy season, and should be done as cheaply as possible. The following system has been found the most effective and economical, costing only twelve rupees to cover a stack containing 2,500 maunds of hay. Instead of using bamboos, the reeds of the common *sărpăt* grass are bound together forming a rough rope, and these ropes are placed over the stack lengthways and crossways to serve instead of rafters and purlins. They are tied together wherever they cross each other, thus making a framework. Of this same material and the *sărpăt* grass itself, small mats 8 feet long × 3 feet broad are next made and placed on the top of the stack framework along the ridge and lengthways. These mats then form the foundation of the thatch, and the thatching is done with *sărpăt* grass in exactly the same way as the roof of a house.

The Measurement of Stacks.

The weighment of hay prior to stacking unsatisfactory.

It has been customary, in order to ascertain the outturn accurately, in many places to weigh all hay prior to stacking it. This entails waste of time and labour, and increased expenditure, and, as the hay is in consequence longer exposed, the risk of damage by rain, heat and wind is increased. These weighments can hardly be considered accurate, as loss by dryage owing to evaporation must occur in the interval between weighing and stacking. The weighment, which lasted all day, had necessarily to be entrusted to subordinates, and was usually very carelessly done; in fact, in many instances, rough estimates were made in order to avoid the tedious task of numerous small weighments. Weighbridges would certainly facilitate weighments, but, even then, the work would be tedious. This system is also followed where the hay is cut and stacked at a contract rate per maund, and it is here in particular that dishonesty can be practised without risk of it being brought home to the parties concerned, owing to the various excuses that they can put forward. Where hay has to be harvested by the contract system, the weight of grass should be calculated by both weight and measurement. In all other cases, the contents of stacks may be ascertained by measurement only. After many years of experiment the following formulæ have been found accurate for ascertaining the contents of stacks. These formulæ admit of the weighment system being dispensed with.

Formulæ for ascertaining the contents of stacks.

In purchasing hay, the contents of the stacks can be ascertained equally accurately by measurement as by weighment.

The contents of a stack can be ascertained by the following formula:—

(1) For the lower portion add the area of the base, the area at the eaves, and four times the area at a height half-way between the ground and the eaves; divide the total by 6, and multiply by the height from ground to eaves.

(2) For the upper portion multiply the mean length of the ridge and the eaves by half the height, and the result by the width at the eaves.

(3) Add together the totals of the upper and lower portions for the cubical contents of the stack.

As an example, let us suppose the stack to be of the following measurements (an ordinary sized stack) :—

For the lower portion—

	feet.
Length of base	60
Width of base	20
Length of base at eaves	70
Width of base at eaves	30
Height (perpendicularly) from ground to eaves	10
Height (perpendicularly) from eaves to ridge	12
Length of ridge	72

The area of base being $= 60 \times 20 = 1{,}200$ square feet,
the area at eaves $= 70 \times 30 = 2{,}100$ square feet,
and 4 times area at height midway between the base and the eaves $= \frac{70 + 60}{2} \times \frac{30 + 20}{2} \times 4$

$= 130 \times 50 = 6{,}500$ c. ft.

The total of these areas is $1{,}200 + 2{,}100, + 6{,}500 = 9{,}800$ c. ft.

Multiply this by 10, the height from the ground to the eaves, and divide the result by 6 $= 16{,}333$ c. ft.

For the upper portion—

Mean length at ridge and at eaves is $\frac{70 + 72}{2} = \frac{142}{2} = 71$

This multiplied by half the height $= 71 \times \frac{12}{2} = 426.$

Multiply this by width at eaves, *i.e.*, $30 = 426 \times 30 = 12{,}780$ c. ft.

Thus the cubical contents of the stack will be 29,113 cubic feet.

A simpler and more easily remembered, though less precise, method of calculation is also given, as it serves all practical purposes, the variation being about 10 maunds in a stack of 2,500.

For the lower portion—

Multiply the mean length at the base and eaves by their mean width and that again by the height to the eaves,—

Thus $\frac{60 + 70}{2} \times \frac{20 + 30}{2} \times 10 = \frac{130}{2} \times \frac{50}{2} \times 10 = \frac{65{,}000}{4} = 16{,}250.$

For the upper portion—

Multiply the mean length of the eaves and ridge by the width at the eaves and that again by half the height from the eaves to the ridge,—

Thus $\frac{70 + 72}{2} \times 30 \times \frac{12}{2} = 71 \times 30 \times 6 = 12{,}780.$

The total of the two portions is $16{,}250 + 12{,}780 = 29{,}030$ c. ft.

The difference in the result obtained by the two methods is thus very trifling (73 cubic feet only) or about $3\frac{1}{2}$ maunds of hay, and this variation will decrease the more the lower portion of the stack approaches a perfectly rectangular shape.

To find the contents of a circular stack, multiply the square of the average girth by ·07958 (the area of a circle whose circumference is I) and then multiply the result by the perpendicular height. This will give the contents of the stack from the eaves to the

Photo by Mr. [illegible]

The Indian plough, showing holes for adjustment and the method of connecting the shaft with the yoke.

Stacking of grass.

ground. For the conical top, multiply the area at the eaves, (*i.e.*, the square of the girth multiplied by ·07958) by one-third of the perpendicular height from the eaves to the ridge.

The density of a stack, or the weight of hay per cubic foot depends upon the following points :— The density of a stack.

1st—The quality (coarseness or fineness) and state of the hay when cut.
2nd—The pressure applied while stacking.
3rd—The length of time taken in constructing the stack.
4th—The length of time the stack has stood.

With regard to the *first point*, it should be noted that long, coarse hay, such as spear grass or any grass harvested off unmanured land which produces only one crop, will not compress so compactly as fine grasses, and therefore the weight per cubic foot will be less for coarse hay than for fine. Similarly, hay which has been washed by rain and re-dried contains little or no moisture, and will weigh less per cubic foot than properly saved hay.

Grasses grown on manured land, chiefly *dub*, *síurí* and *janewar*, having finer stems and more foliage, compress well, and consequently weigh heavier per cubic foot than coarse grasses.

With regard to the *second point*, it is apparent that the density of a stack well trampled during construction, will be greater than that of a stack made with an elevator, and to which little or no pressure has been applied.

With regard to the *third point*, the length of time taken in constructing a stack, affects the density considerably. A stack for instance which was constructed in two days would, of course, not be so dense as one made in twenty days, because the latter has had time to compress by its own weight.

The *last point*, *viz.*, the "length of time the stack has stood," is the most important of all; for all stacks, whether slowly or quickly constructed and whether composed of fine, coarse or damaged hay, will sink very considerably after completion. A stack probably goes on settling slightly for years after construction and more rapidly after exposure to heavy showers of rain.

(*a*) A newly-made stack of coarse hay, slowly stacked, contains from 3·9 to 4 pounds per cubic foot, while a stack of fine hay contains from 4 to 4·3 pounds.

(*b*) If quickly stacked, the weight would be from 3·5 to 3·6 and 3·6 to 3·9 pounds, respectively.

(*c*) The same stack, if measured two months after, would give a density of—

Coarse hay 3·9 lbs. to the cubic foot.
Fine hay 4·9 lbs. „ „ „

After six months—

Coarse hay would be 4½ lbs. to the cubic foot.
Fine hay „ 5 lbs. „ „

After six months the variation is slighter, but it may be noted that stacks usually sink very considerably in the monsoon.

A notice board should be affixed to each stack showing the following particulars— The stack to be labelled.

(*a*) Date when stacking commenced.
(*b*) Date when stacking was completed.
(*c*) Dimensions of stack when completed.
(*d*) Description of hay.
(*e*) Name of plot from which collected.
(*f*) Estimated contents in weight.

To which should be added after the contents of the stack have been issued—

(*g*) Dimensions at time of issue.
(*h*) Date when opened.
(*i*) Quantity of hay found by actual weighment in issuing.
(*j*) Loss or gain over estimated quantity.

When no extra expense is incurred thereby, it is a good plan to cut the stack for issues with a hay knife. This is especially convenient where the issues are not large How hay should be issued.

and where it consequently takes many days to issue the contents of the stack. Of course, where the issues are very large and the whole stack is consumed in four or five days, it would not be practicable or advisable to use the hay knife, as its use would cause great delay and waste of labour as the number of cutters required could not all be simultaneously employed, and thus many would remain idle. In the case of large issues, the best plan is to roll off the hay from the top of the stack, commencing at one end, so as to avoid exposing too much of it to the weather at any time. This will result in the loss of a little moisture owing to exposure. The hay knife shown in plate 26 is a suitable one.

Protection against Fire.

Means generally tried for extinguishing fires.

The protection of stacks from fire has always been a most perplexing question, many means having been tried,—some of them both expensive and useless. Chatties and kerosine oil-tins filled with water have been kept near stacks for use in case of fire, but the small quantity of water which they could hold would be practically useless in case of fire. Sand would certainly be useful if the fire were detected in time, but in almost every instance the fire is far advanced when the alarm is given; and it spreads so rapidly over the stack that any attempt to save the hay must be prompt.

Beating out the flames recommended.

It is advisable to keep an iron ladder and a few iron rods, or some brushwood, near each stack with which to beat out the flames. There would probably be time enough for this, but none for laying on either sand or water. In a stack of long standing, fire does not penetrate quickly and even after being on fire for some hours it is possible to save a very large proportion of the hay. Firing stacks in India is usually the work of incendiaries. Spontaneous combustion is hardly possible in the plains of India, the hay being made usually from one crop and containing very little moisture. Moreover the cocking of the hay prior to stacking dries any extra moist hay. Not a single case of spontaneous combustion has occurred at Allahabad, where 200 large stacks have been constructed during the past 19 years.

Three chowkidars for each stack.

It is therefore obvious that rigid protection alone will ensure the safety of hay stacks, and if the instructions which follow are observed, the risk will be minimised. Stacks should be guarded night and day, and for this purpose, three chowkidars should be placed in charge of each. As these men must live on the spot, two small huts with iron supports and galvanised iron roofing should be erected at each stack, directly opposite each other at a distance of 50 yards from the stack. Huts of this description are recommended because of their mobility, durability, and non-inflammability. The chowkidars should be visited occasionally at unexpected times during the night by one of the farm assistants. The chowkidars should challenge any one approaching within 100 yards of the stack; and a Station order prohibiting the approach of European and native troops within that distance should be published. No smoking or cooking should be allowed within the limits mentioned, and, on a stack's completion, all loose hay lying about its base should be at once removed.

CHAPTER XVII.

Machinery and Implements.

The following machines and implements are commonly used in this country for cutting and harvesting grass :—

The scythe, the *jhabau*, the *khŭrpa*, the *hassia*, the *daranti*, the mowing machine, the tedding machine, the horse-rake and the chaff-cutter.

The scythe unsuitable to India.

The cost of a SCYTHE is about Rs. 7-8. There is a great knack in sharpening this implement, and a special sharpening stone is necessary, costing 2 annas. Owing to the coarseness of the ordinary Indian grasses, it is almost impossible to work satisfactorily with the scythe, except when the grass is quite young and tender. Europeans who have been accustomed to work with a scythe in England, fail to do one-fourth of the work they could easily accomplish there. An experienced workman will cut from three-fourths of an acre to two acres a day with the scythe, according to the heaviness

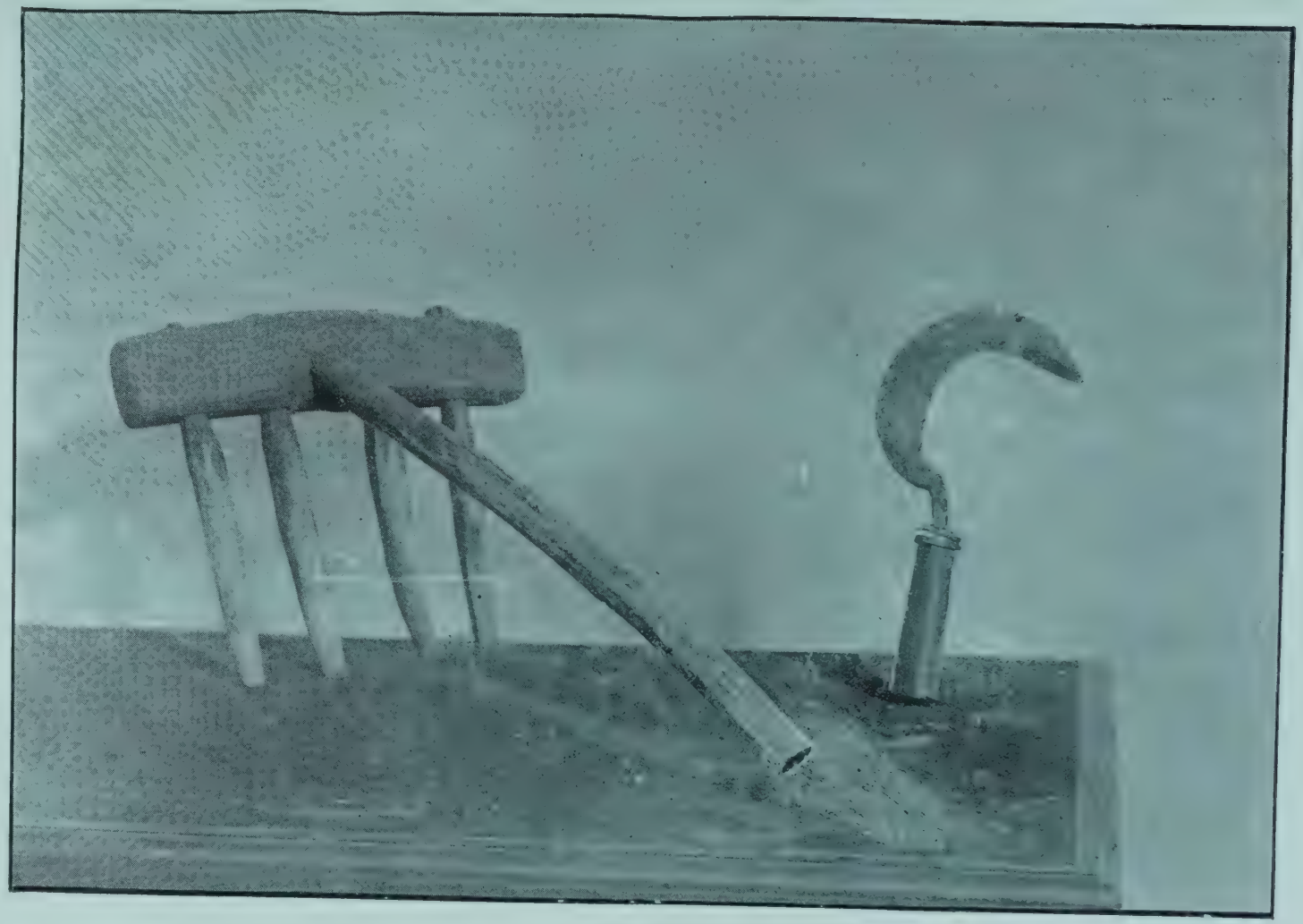


Photo block. Survey of India Offices, Calcutta, 1902.

The "*pāchā*" (manure-fork) and the "*hassia*" (sickle).

of the crop. Natives have been taught how to use this implement and have been paid double wages for their work ; but the results have been only satisfactory as long as the grasses were young and tender. Spear grass (*hetropogon contortus*), *anjan* (*penisetum cenchroides*), and *janewah* (*andropogon*), if attempted to be cut with the scythe when mature, merely give way and bend over. These grasses, moreover, grow largely in tufts, which is another source of difficulty in working the scythe. At Calcutta, where the grasses are finer, scythes are largely used. Even in England, on sewage farms where the crop of grass more closely resembles the heavy Indian grass crop, the scythe is used with some difficulty. The scythe, however, may be used with advantage on lawns or on any manured land, if natives of stout physique are obtainable and are trained to the work. The men should be paid double the ordinary wage, as it is far more tiring to a native to work standing than to squat. (For scythe see plate 27.)

The *Jhabau* and its use.

The JHABAU is an implement used chiefly in the North-West Provinces, and seldom seen in other parts of India but it is being rapidly introduced. It is practically a small scythe with a short handle for use in a squatting position, and makes a clean cut, like that made by the scythe, as close as possible to the ground. It can be used on rougher ground than the scythe or as a jagging or bagging machine. It is used in three different ways :—

(1) with a semi-circular sweep like the scythe ;
(2) with a short cut ;
(3) with a saw-cut ;

but the two former are the better methods.

A *jhabau* costs from 8 annas to Re. 1-4-0 (according to the quality and weight of the steel). It is made of about one pound of the best steel or rather more for a strong man, and its handle is made of *babúl* wood.

On manured land, producing 150 maunds of grass per acre in one cutting, a skilled labourer can cut as much as 30 maunds in a day with this implement; while an ordinary coolie or female grass-cutter can cut from 12 to 15 maunds daily. Grass cut for hay with the *jhabau* is free from dirt and quite as clean as when cut by a mowing machine. Owing to the cut being a clean one, the grass germinates again more quickly than if cut by some of the other implements. This should be the only implement used, except, perhaps, the scythe for manured lands. With any other implement or machine, it would be impossible to get the full outturn or the required number of cuttings. The *jhabau* should be kept carefully sharpened, for when blunt it tears up the grass by the roots.

The *Khŭrpa* and its uses.

The KHŬRPA is a short and broad implement resembling a chisel. Its usual weight is about 1¼ pounds, and, including the handle, it costs 8 annas. The chief objection to the use of the *khŭrpa* is that it is impossible to cut the grass without grubbing up a quantity of the earth and roots. It should never be used during the rains, as it spoils the crop, and, moreover, smoothes and puddles the top surface of the ground, which interferes with the growth of the next crop. The best time for using the *khŭrpa* is during the dry season, or, from the beginning of October to the middle of June, or commencement of the rains. At this season, indeed, the *khŭrpa* is a necessity, as it alone can cut the short aftermath, while, at the same time, it loosens the top friable surface of the soil, thus preventing excessive evaporation. Its use is often objected to even in the dry weather, on the ground that it drags up the grass by the roots and injures it. This, however, is not the case—it being beneficial to use the *khŭrpa* in dry weather as frequently as possible, as *dub* grass especially sprouts very quickly after being cut with it. When the ground is dry, this implement does not tear up the roots. Another objection frequently urged against its use is that it leaves the ground in a very barren state. This, however, is only a very temporary eye-sore, as young and green shoots very quickly appear. When grass for hay is cut with the *khurpa*, which is occasionally necessary owing to the crop being too short to be cut profitably with any other implement, particular care should be taken that no tufts or earth are mixed with the hay, otherwise the hay will be inferior. As in the case of other implements, it is necessary to frequently sharpen the *khŭrpa*, probably three or four times an hour.

Objection answered.

Machinery and implements.

The *Hassia* and its use.

The HASSIA (see plate 20) should not be used except in the case of rukh lands and jungle grasses, where rocks and brushwood abound. It costs from four to eight annas to manufacture. In using this implement the grass has to be held with one hand, while the cutting is done with the other. The heaviest part of the crop, about 5 inches from the ground, is unavoidably left standing. When the ground is soft and moist during the rains much of the grass is torn up by the roots. One advantage of the *hassia* is that the hay can with it be cut free from dirt and roots. Natives can be made to cut closer to the ground than the 5 inches above mentioned, but the process is slow, as with this implement much less grass is cut in a day than with the *ghabau* or *khŭrpa*. The *hassia* is best suited for cutting grain crops, or for cutting grass by the *pula* system.

The *Daranti*.

The DARANTI (see plate 24) costs as much to make as the *hassia*, which it resembles. It has, however, a larger blade than the latter, is not quite so curved, and has a serrated edge. It is largely used in the Punjab, but it is not suited for use on cultivated grass lands.

The Mowing Machine.

The mowing machines chiefly in use in India are "Walter Wood's Mowers." (See plate 30.) They are of American manufacture, but can be obtained in Bombay from Macbeth & Co. at about Rs. 210 each.

Wood's mowing machines.

These machines cut close enough to the ground in upright growing crops of grass, and, being light, are very suitable. A more recent machine known as the "Tubular Mower" has been introduced by the same makers, which is even more suitable and is especially adapted for bullock draught. For a long time there was a prejudice in India against the use of machines, chiefly due to native prejudice and ignorance of the proper methods of looking after machinery. The first machine tried at Allahabad was one of Howard's. This was undoubtedly a failure, as it was unusually heavy and cut higher, leaving 6 inches of stubble on the ground. After cutting a plot of 50 acres with this mower, the aftermath was subsequently cut with the *khŭrpa*, with the result that the weight of the aftermath exceeded that cut by the mower. As a rule all these machines are drawn by horses, and in 1891 the use of battery horses was sanctioned for drawing them. In some instances four horses were harnessed to each mower, as the land was damp and the grass coarse. The horses, however, being untrained, and the European drivers unable to stand the heat, the outturn of work was not remunerative, and the use of horses was abandoned. Mowers can also be worked with mules, but the best and cheapest method is bullock draught. Quick-stepping and powerful bullocks, such as are to be found among the siege train animals, are required for this work, and they are readily trained to it. The following advantages are derived from the employment of bullocks. They can be quickly stopped where obstacles are met with, and accidents and breakages are thus minimised. The cost on feed and keep is less for bullocks than for horses, and the wear and tear of their gear is considerably less. Where, however, Government transport mules are obtainable free they may of course be utilised.

Howard's mower.

Bullocks best suited for mowers.

Work done by a mower.

Whatever animals are used, it is necessary to have at least two pairs with drivers for each mower, working the animals only for two hours without a change; the work being very exhausting. The animals, too, must be well fed. With two pairs of good bullocks, a mower will cut in a high standing crop from three to four acres daily. In a thick-bottomed crop, such as *dub*, on manured land, from two to three acres is a good day's work.

The draught of the mower.

It will be observed from plate 30 that the draught is not from the pole, but from the centre of the body of the machine. The pole or shaft is merely intended to balance the mower and keep the knife at the right angle for cutting. The pole works backwards and forwards, so as to admit of the strain being taken by the traces. The yoke is attached to the pole merely by a rope, which admits of a certain amount of lay, while at the same time it prevents the yoke (and the bullocks with it) receding upon the knife. If this precaution is neglected the bullocks are liable to be injured by the cutting knife.

Photo-Block. Survey of India Offices, Calcutta, 1903

Land being trenched with town rubbish. Men digging the trenches and the carts depositing rubbish.

Machinery and implements.

Hand labour cheaper than machinery.

In Europe, the use of machinery has been brought about by scarcity and dearness of labour. In India, however, labour is plentiful, and harvesting operations can be conducted more cheaply than by machinery: so that machinery does not possess the same advantages in both countries—though the advantages derived from the use of some machines, such as chaff cutters, corn and oil-cake crushers, pulpers, etc., etc., are identical. The principal advantage gained in India from the introduction of harvesting machinery is, that the heat is so great and the winds are so hot and drying that the grass crop often withers before it attains maturity, especially when the rainy season ceases early. Without the use of mowers, it would often be impossible to cut the hay crop in time.

Manured grass unsuitable for mowing.

There is, however, one drawback to the use of the mower on manured grass lands. The mower works on the principle of the scissors, and not only cuts the grass, but crushes and bruises it, whereas the scythe or *jhabau* effects the clean cut of a knife. The cut of the two latter implements is regarded as being less injurious to the grass and they are consequently used in preference. It has been found by experience that manured land cut by mowers will yield fewer cuttings and smaller outturns than similar land cut with the *jhabau* or scythe. It is not therefore advisable to use mowers on such land.

The knives to be kept sharp.

Great care is necessary to keep the knives well sharpened and for this purpose a trained workman should be entertained. In a thick, coarse crop, the knives require constant attention, which, if not given, results in accidents and breakages. One man can sharpen sufficient knives to keep six or seven mowers going constantly. There should be at least two knives to each machine, which ought to be changed and attended to several times during the day. As blunt knives result in extra strain to the draught animals, breakage of gear, and bad cutting, too much attention cannot be paid to this particular work. The best method of sharpening these knives is with a patent grinding stone intended expressly for this purpose. It can be had of Macbeth Brothers & Co., Bombay. They can also be sharpened with the ordinary grindstone or with hand files, but care should be taken to avoid pointing the sections.

How to drive the mower.

Straight driving is an important point in working mowers, that is to say, the bullocks should be driven straight so as to avoid either leaving strips of uncut grass between the tracks, or on the other hand to waste time and labour by not cutting with the full length of the knife. It is therefore necessary for one man to drive the bullocks from the top of the gear box, while another works the machine. The man who drives should take care that the off bullock keeps on the edge of the track recently cut. If this is done, the driving will be straight, and the cut will be the full length of the knife.

When the crop is high and heavy, it falls from the mower in thick swaths, generally on the track, to keep which clear it is necessary to entertain a lad to walk in advance and rake it aside, or better still tie a rope from the ground board to the lever.

The care of the machinery.

As a rule, machinery should not be left to the sole care of natives, as they easily get out of order and require constant oiling of all parts and bearings, especially those connected with the knife. Each driver should be in charge of his own machine, should understand its mechanism, and should be provided with a spanner and an oil can. He should frequently examine and oil the bearings, and be responsible that no nuts are lost. The gear enclosed within the box especially requires constant oiling, say, every half hour, while the wheels and other unimportant portions only require oiling every two hours. The knife blade frequently breaks, and as it is a somewhat costly part, the repairs form a heavy item of expenditure. The most economical method is to buy steel and make new blades on the farm. For this work a skilled fitter is necessary. Other component parts are obtainable from Macbeth Brothers & Co., Bombay. Lard may advantageously be used for oiling purposes; but on no account should castor oil or other common oils be used. Machine oil, which can be obtained from the firm just named, should alone be used.

When harvesting operations cease, all machines should be stored in sheds after being thoroughly cleaned and overhauled.

The Tedding Machine.

The Tedder.

The TEDDER OR HAY-MAKING MACHINE (see plate 28) is most useful and economical. The most suitable draught is horse or mule—bullocks being hardly fast enough for the work, which is heavy, especially where the swaths to be opened out are very thick. The hay can be made very rapidly by the tedder, without damage to the hay as is the case when handled too much. With manual labour there is always a tendency to scamp the work, by neglecting to turn or open out the thick swaths, which, especially in cloudy weather, results in inferior hay. The tedder should follow the mower, so as to open up the swaths immediately they fall.

Two actions.

There are two actions, backward and forward; but in India where the heat is so great and dry winds prevail, the backward motion should be used. This admits air and heat without exposing too much of the grass at one time and causing loss of fragrance and colour. It is also easier work for the animals engaged. When it is desired to change from the forward to the backward action, the machine should first of all be put out of action by returning home the catch provided for this purpose and the backward catch should be raised. Tedding can also be done by labourers using forks, but it is a more expensive process. Owing to the grass cut by the mower in India being usually one crop of hay grass, which is long and frequently full of creepers, such as *mote* and *oord*, the machine is apt to clog with the forward action, necessitating stoppages for freeing the entanglement. It is, however, occasionally necessary to use the 'forward' action, as in the case of grass cut by the *khŭrpa*, this action being the best suited for removing the dirt which cannot be entirely avoided in cutting with the *khŭrpa*, and which it is very desirable to remove. The 'forward' motion throws the grass back heavily on to the ground, where it lies close, so that little air penetrates it. To open it up, the "backward" action must be used.

The Horse Rake, the Chaff-cutter and the Corn-crusher.

Its usefulness.

The HORSE RAKE is a very useful and valuable machine. Before the introduction of this machine, coolies had to be employed with wooden hand-rakes to collect the hay, and even then a large portion was unavoidably left on the ground, and the expenditure incurred was great. The rake leaves little or no grass on the ground, and does the work far quicker than it could be done by manual labour. The raking for cocking should be done *expeditiously*, in order to collect the hay into wind-rows before the dew commences to fall. The work should be done *systematically*, and the whole field or area traversed by the machines in parallel lines, so that no spot shall be left untouched, and the travelling of the animals unnecessarily over the same ground avoided.

Best draught for it.

The horse rake is best drawn by mule or pony. Two mules should be allotted for each machine and should work alternately for two hours. The transport saddle is unnecessarily heavy and clumsy for this work, and it is economy to provide simple, light and cheap harness for the purpose, consisting of short traces attached to the ordinary breast-bands, with a light saddle and straps for supporting the shafts (as per plate No. 29).

The rake is very light and well made, but the wheels are weak and liable to frequent breakages owing to the axle-boxes being made of cast iron, which snaps easily. Walter Wood & Co.'s machines can be obtained from Macbeth Brothers at Bombay and are now fitted with trip action. This does away with the necessity, which existed in former rakes, of releasing the hay from the rake by lifting the lever with the hand. It is now only necessary to keep the right foot on the iron lever lightly, and let it work up and down with the lever, without removing it, while the left foot is free to touch the trip action when it is desired to raise the rake and drop the hay at each wind-row. The left foot does not rest on the trip action, but merely touches it and slides off at once. After the wind-rows have been removed to the cock it is advisable to run the rakes over the places where the wind-rows stood, and in fact over the whole area, to gather up any locks of hay that may be left. The rake can,

Photo-Block. Survey of India Offices, Calcutta, 1903.

A crop of *dúb* grass, three weeks after sowing, on land trenched with town rubbish.

Machinery and implements.

with a well-trained mule, be worked by an intelligent lad, who should also be taught to do the oiling, the only places being at the axles.

The Chaff-cutter and how to use it.

The CHAFF-CUTTER is perhaps the most valuable machine on a farm. But this does not refer to the little gim-crack hand machines, which require frequent repair and are capable only of providing chaff for a few cattle. The best results can be obtained by using large and powerful machines driven by steam (see plate 31). One small engine will drive four or five chaff-cutters and grain-crushers, while each chaff-cutter can, in a working day, chaff the whole of the fodder ration of 100 cattle. These large machines can, it is true, be also worked by hand power; but the outturn is far smaller, the process is slower, and the expense greater, than if worked by steam. Some of the best grasses, when the stems are coarse, are refused by cattle, but when chaffed are readily eaten; and even the worst grasses, such as *kansa*, *kusa* and *ganrar*, when chaffed are readily eaten by cattle.

Chaffed fodder is especially valuable for horses, as it is easily digested and little is wasted. *Karbi*, guinea grass, and the various kinds of *sorghum*, must necessarily be chaffed; and the cultivation of these crops is very profitable, as they all make excellent fodder. Good chaff-cutters can be purchased in the country at from Rs. 400 to Rs. 600 and the best are those manufactured by Carson and Toone, of Warminster, England. As in the case of the mowing machines, the knives require to be frequently sharpened. The file should not be used for this purpose too frequently, as it wears away the blade. The grindstone is therefore more serviceable.

All farms should be equipped with the chaff-cutter.

Every farm should be in possession of several of these machines, which will very quickly repay the cost of the initial outlay in the fodder saved; while Officers Commanding Mounted corps much appreciate the boon of obtaining at least a portion of their ration in chaff for mixing with the grain ration. Good chaff-cutters can be adjusted to cut to any length, from ½ inch to 2½ inches. It is necessary to see that bricks and stones are not thrown into the feeder with the grass, also that the machine is properly oiled. One of these machines of the better kind in constant use, with ordinary care, should last for eight years. The knives, of course, must be periodically renewed, and a reserve stock for this purpose should be kept. It is advisable to order two dozen spare knives with each machine.

An example of its usefulness.

The following is quoted as an instance of the value of chaff-cutters. In the earlier days of the Allahabad Farm, about 15,000 maunds of grass were condemned as being too coarse for transport animals. Sir Herbert Macpherson had the entire quantity chaffed and tendered again for issue. The animals ate it greedily and throve on it to the entire satisfaction of the Transport Officer in charge who was prepared to accept more of it if more had been available.

The Corn-crusher and how to use it.

The CORN-CRUSHER (see plate 32) is also a very useful machine and may be classed next in importance to the chaff-cutter. As in the case of the chaff-cutter, it is useless to purchase small machines like the Beaufort-Hunt Crusher, which may be suitable for a hunting stable of a dozen horses, but is quite unsuitable for a large number of animals, such as in a cavalry regiment or transport depôt. These light machines, moreover, soon get out of order. A good machine costing some Rs. 600 will kibble oats, maize cobs, grain, barley, or any other grain. Those manufactured by Messrs. Bamford Sons, of the Leighton Works, Uttoxter, England, are good machines. They can be adjusted either to merely bruise the grain, or to grind it very fine. One machine driven by steam along with other machines will grind about 10 maunds and crush about 14 maunds per hour. It can also be worked by hand, but with inferior results. Grain thoroughly crushed requires no soaking, and can be easily digested by old as well as young animals. It is a common thing in India to see cattle and horses passing in their dung quantities of gram, oats, and other grain in a whole state. This is not merely so much grain lost, but is a fruitful source of disease caused by irritation.

The Cake-crusher.

The CAKE-CRUSHER (see plate 33), to people who know the value and economy of feeding on linseed and other cakes, is an extremely useful machine. Driven by steam, a small crusher, costing Rs. 300 to Rs. 400, will crush 8 maunds per hour.

The PULPING MACHINE saves much labour and expense in pulping turnips, carrots, potatoes, etc., and is a useful machine on a farm.

Machinery and implements.

Plate 31 shews all the machines worked by the one shafting in the chaffing shed.

Hay Presses.

The points of good hay presses.

Hay Presses are very necessary on a farm where grass has to be brought in from outlying rukhs by rail or road, and for despatching hay for field service or camps of exercise. The chief points to be looked for in a press are :—

(*a*) The outturn.
(*b*) The dimension and weight of the bale turned out, so as to suit mule or camel carriage.
(*c*) The density (for despatch by rail at the cheapest rate, the bales should be pressed to a density of 90 cubic feet to the ton).
(*d*) Economy of fuel and labour.
(*e*) Simplicity of binding.
(*f*) Portability.

A few of the more important presses experimented with, and their advantages and defects are mentioned below.

The ordinary maxim that "the best is the cheapest" holds good with this as with all other machines, and all money spent on inferior presses which do not answer all the requirements above noted is money thrown away.

The Bombay Trading Company's Press.

The BOMBAY TRADING COMPANY'S PRESS was experimented with in 1885, at the time of the Russian scare. It was used for compressing fodder for animals railed to the base of operations. It was an upright screw press and was an absolute failure for the following reasons :—

(*a*) It took unduly long to fill the boxes, as the hay had to be trampled in by coolies with their feet.
(*b*) The outturn was very small, some 25 bales of 2 maunds each only.
(*c*) The dimensions and weight were unsuited for mule carriage, and the bales were not easily handled.
(*d*) The density was far below the standard required by the railway companies for the special rate.
(*e*) Though there was no fuel required, the labour necessary was out of all proportion to this outturn.
(*f*) The binding was done with ropes, and was ineffective, besides taking much time.
(*g*) The machine was not easily moved from stack to stack.

In addition to the above defects, the bales frequently jammed in the chamber, and this resulted in much loss of time.

The American Hand Truss Press.

The AMERICAN HAND TRUSS PRESS is a very cheap one, costing only about Rs. 100, but as it fulfilled none of the above mentioned requirements, it was dear at the price. It was also a box press and had to be filled by foot pressure.

Ladd's Double Boomer Press.

A DOUBLE BOOMER PRESS was imported from England by the Commissariat Department from John Ladd of London. It cost Rs. 15,000, exclusive of the freight. It was certainly portable but did not meet any of the other requirements of a good press. The binding was faulty and slow, necessitating a man lying on his back under the machine to pass the bands or ties up through the slot to the other tier on the top of the machine. The outturn was comparatively small, about 100 bales per working day. The bale frequently jammed in the chamber, while the system of filling was also faulty, as it necessitated coolies trampling in the hay with their feet. As in the case of the other presses, the only good point about this machine, besides its portability, was that it was wholly constructed of steel and iron, the materials best suited for the climate of India. Otherwise it was a complete failure.

Jessop's Single Hydraulic Press.

JESSOP'S SINGLE HYDRAULIC PRESS worked by hand-power was an improvement on the above. But the feeding boxes of this press were too small to admit of one maund of hay being filled, and the outturn was small, being only some 80 bales a day. The good points were economy of labour, only six men being required to work

Photo-Block

Survey of India Offices Calcutta 1912.

Land trenched with night-soil under the shallow system, with trenches open for the deposit of night-soil.
A young plantation of trees on land previously trenched.

it, and regulation dimensions of the bale. It was not, however, portable, and was better suited for pressing *bhoosa* than hay.

Jessop's Double Hydraulic Press.

Jessop's Double Hydraulic Press is a further improvement on this machine in the following respects :—

(*a*) It is worked by steam, enabling a much larger outturn to be obtained.
(*b*) It has two boxes, thus saving time in filling ; while one box is in the press, the other is being filled.
(*c*) The boxes are made large enough to admit of one maund of hay being inserted.
(*d*) The water tank on the top of the original press is replaced by a pump worked by steam.
(*e*) The binding is simplified by the introduction of patent ties.

It is the only really suitable press for *bhoosa* that has been experimented with and for *this* purpose the fact of its not being portable is of no consequence. As a hay press, however, it fails in the following points :—

(*a*) Non-portability.
(*b*) Deficient outturn (some 150 bales a day).
(*c*) Faulty filling process, as the hay has to be trampled by foot in the bale chambers.
(*d*) Inability to press rukh grass to the required density.

Ladd's Chaff and Hay Press.

Ladd's Patent Bhoosa Chaff and Hay Press answered well for hay but not for *bhoosa*, for which it was specially imported from England. It was made of timber instead of steel, although steam machines are now made by this maker. Timber is liable to deteriorate quickly from exposure to sun, rain and the atmosphere.

Dederick's Perpetual Press.

Dederick's Patent Perpetual Presses are (plates 35 and 36) the very best which have ever been received. Those on the Allahabad Farm have not the latest improvements, as they are made of timber, but presses can now be obtained entirely of steel, and with other improvements ; they are the best presses in the market for hay. The two machines now on the Allahabad Farm were originally imported from England in 1885, and were sent to Meerut, where an attempt was made to work them by hand. This naturally resulted in failure, and the presses were pronounced useless. They were eventually made over to the Allahabad Farm, where they did excellent work from 1890 to 1898. They have turned out, when in serviceable condition, 300 bales a day of one maund each. They are very portable, being drawn from stack to stack by a pair of bullocks. The feeding arrangement is perfect, there being no interruption in the process, and the need of trampling the hay into the feeder is dispensed with. The binding is quick and simple, while the bales can be made to any length required. The whole process is perpetual, there being no necessity for stoppages. It is very economically worked, requiring only two men for binding, two for feeding, and one for bringing up the hay. In addition to these, one bhisti and one driver are required for the engine, making a total of seven men. These presses are not suited for pressing *bhoosa*, but Dederick's new presses are. They are in fact the ideal presses for India.

Hand pressing can never be effective, especially when the operations are extensive, and therefore steam-power should be applied in all pressing operations. Pressing by hand-power will not ensure the hay being pressed to the required density, and the process is considerably slower than steam-power pressing.

Points to be looked to when buying a press.

In purchasing a press the following points should be looked for :—

(1) The outturn should not be lower than from 300 to 400 bales per diem.
(2) The bales should weigh as nearly as possible 80 pounds each, a convenient weight for mule carriage and easy in handling.
(3) They should be pressed to a density of 90 cubic feet to the ton, or, say, 25 pounds to the cubic foot, so as to admit of despatch by rail at the special rate charged by railway companies. To qualify for this rate, the cubic contents of each bale must not exceed $3\frac{1}{4}$ cubic feet, and a convenient size for a one maund bale of this capacity is $24'' \times 17'' \times 14''$, which is a convenient mule load, and just fulfils the special rate condition.
(4) If trees are planted, as is usually the practice on well managed farms, no expense ought to be incurred on account of fuel for engines, as their loppings and prunings, carefully attended to, should suffice for

the purpose. It is therefore important that the engine purchased should be capable of burning either timber or coal.

Wire recommended for binding.

Wire is best suited for binding as it is stronger than other materials; and ties, similar to those shown in plate 37, should be made up. The double end passing through the loop prevents breakages, which would frequently occur if the wire were single. On active service, these wires, when the fodder has been consumed, are useful for many purposes, such as the construction of sheds for stores or sick animals. In peace time the ties can be repeatedly used, while rope or other material would serve only for the occasion.

A bhoosa press need not be portable, since *bhoosa* when purchased has to be stored and the press can be permanently set up at the place of storage. In the case of hay, however, it is necessary that the press should be easily moved from stack to stack, or even sent to distant outlying rukhs. It should be easily drawn by a pair of bullocks, and must be mounted on wheels.

Any press which requires the hay to be trampled in with the feet, as already described, is undesirable, because the process is slow, and in treading grass into the box the coolies are liable to have their feet pierced by stiff stems of coarse grass or thorns, with the result that, from fear of injury, the pressing is not properly done and the bales though of the required size are not of the requisite density. The best system of feeding is that noticed above in the remarks on the Perpetual Press. In this, the coolies merely throw the hay into the hopper, and the machine automatically presses it down into the chamber in time for the traverser to force it home into the bale chamber. This mode of feeding has also the advantage, that each hopper-ful of hay is compressed into a number of trusses, so that the bale, when completed, comprises a number of trusses, and when it is opened—instead of scattering, as is the case in other presses—the hay can be removed by the truss as required.

CHAPTER XVIII.

Grasses.

Grasses.

There are throughout India some 50 to 60 grasses, the majority of which are to be found in most districts; the vernacular names of course vary in different districts. About 20 of this number are excellent fodder grasses for horses and other animals, though the prevailing idea among Europeans is that only some three are good fodder, while many even will admit into their stables nothing but *dub* or *harriali* (*cynodon dactylon*). This is probably due to the fact that grass is not generally cultivated in India. *Dub* is usually found on cultivated land or culturable lands, in river-beds and on roadsides. Prior to the inauguration of grass farms, fodder for horses was always obtained by sending grass-cutters into the district. The grass was generally taken from the lands of the ryots, and being previously grazed by cattle, it was short and fine. The other descriptions of grasses were hardly known, except to the natives. *Dub*, therefore, was looked upon as the only grass suitable for horses. It is undoubtedly a good grass, but it is by no means the best when compared with other 'cultivated' grasses. Owing to the heavy rainfall in most parts of India, and the consequent rapid growth of grass and other vegetation during the rainy season, indigenous grasses are, to the eye of one accustomed to English meadow grass, somewhat coarse and broad-leaved. Yet many of them are just as nutritious as the best of the English grasses.

Grasses in India are either:—

(*a*) Perennial; or (*b*) Monsoon.

Perennial grasses, as the name implies, are those which grow from year to year; the monsoon grasses only appear above the ground after the commencement of the monsoon, and die off shortly after its termination. There are good and bad quality grasses among both; the monsoon grasses as a whole being in no way inferior to the perennial, even though they contain a larger percentage of water.

The following is a list of the principal grasses to be found in most parts of India. The names vary in almost every district: but as far as can be ascertained, those given below are fairly correct.

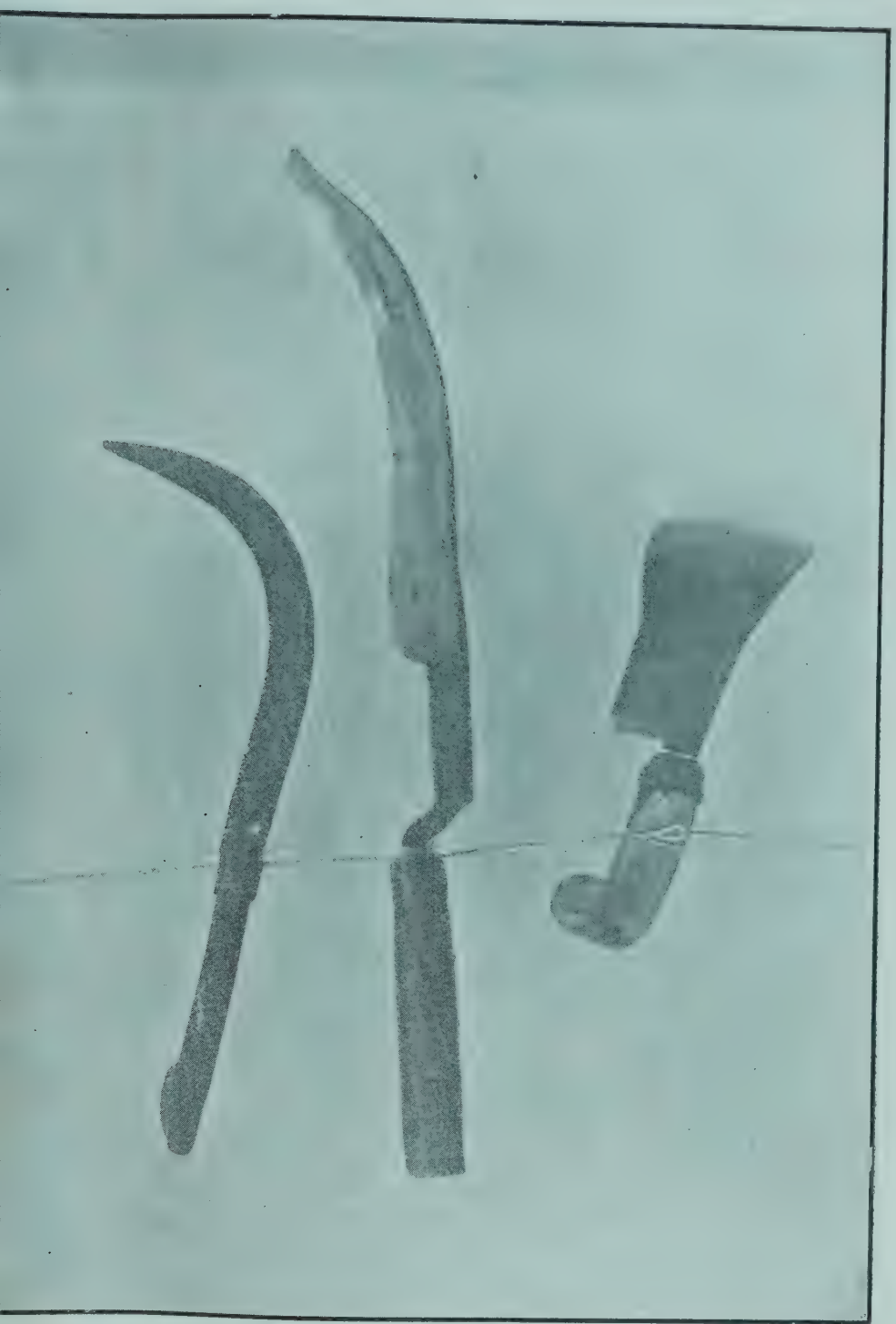


Photo-Block.

Survey of India Offices, Calcutta, 1902

Darauthi, Jhabau, and *Khurpa.*

Grasses.

,, annulatus.	Janewah, a long stemmed variety.	Do.	Do.	Do.	Do.	Do.
,, faveolatus.	Janewah (usar).	Do.	Do.	Do.	Do.	Do.
Pennisetum Cenchroides.	Anjan (hairy).	Sivali.	.....	Dhamman.	Jiral.	.....
Cenchrus Bi-florus.	Anjan.	.....	.....	.....	.....	.....
Cynodon Dactylon.	Dub.	Doorba.	Hariali.	Khabbab.	Harali.	Myai Bah.
Iseilema Laxum.	Musel.	Durbi ghass.	Pinashrappa.	Gandhi.	Musan.	Young Bow. Myetynapya.
Thloris barbata.	Jargah.	Phulkia.	Kunjanki.	Palwai.	Bardina.	Myae-yo-wa.
Andropogon Contortus.	Parbah.	Kher.	Sharpul.	Suriala.	Bhaloo koosel.	Youg myayi.
,, Halepense.	Bharwi.	Baroo.	Kodyapul.	Burroo.	Baroo leads.	Myet Kha Ywa.
Ischæmum Laxum.	Sen.	Sen.	Coly Pillu.	Sin.	Gawan.	Young Bow Myiaya.
Andropogon pomilus.	Karta.	.....	.....	.....	.....	.....
Ophiurus corymbosus.	Sonta.	.....	.....	.....	.....	.....

MONSOON.

Paspalum Sanguinale.	Siuri.	Makurjali.	Panapalu.	Yaarakari.	Chikari.	Yay Myetchinnyetya.
Eleusine Aristata.	Makra.	Murha.	Ragi.	Mandwa.	Mandaya.	Do.
,, Egyptiaca.	Kharmakra.	Mathna.	Mathaniya Pil.	Madhana.	Chikara.	Do.
Panicum crus Galli.	Sewain.	Dul.	Peddawonao.	Samvaki.	Honna.	Yhamari Myet Kha.
,, Colonum.	Sanwah.	Shama.	Woodoogodi.	Janlisanwak.	Gawa.	Do.
Apluda Varia.	Bhanjura.	Durighas.	Pootsakangdi.	Ganni.	Gugargadi.	Young Bow Myetywapya.
Panicum jasvanicum.	Chupraila.	Jaloganti.	Kobachipina.	Buriya.	Somwan.	Yhamari Myet.
,, prostratum.	Do. (small).	.....	.....	.....	.....	.....
Eleusine Indica.	Makraila.	.....	.....	.....	.....	.....

The above are the best grasses. The following, though somewhat inferior, are suitable for cattle.

Anthisteria ciliata.	Bhoru.	Titar.	Gonair.	Ghandi.	Biggodah.	Young Bow. Myet Pinda.
Phragmites Communis.	Motha.	Motai.	Midai pilla.	Dela.	Do.	Thalkai Arungai.
Aristida adscenscionis.	Lapa.	Lappa.	Sivoo pilla.	Lamp.	Lapri Dhoula.	.....
Andropogon squarosus.	Ganrar.	Bena.	Vetwar pilla.	Panni.	Urai.	.....
Saccharum spontaneum.	Kansa.	Khajara.	Pellogadi.	Kana.	Karagadi.	.....
Polinia eriopoda.	Baghai.	Babur.	.....	Bhabar.	Nulka gadi.	.....
Erianthus Ravennæ.	Bhamani.	Dholee.	.....	Do.	Do.	.....
Sitaria glauca.	Gen bandari.	Buga-nakhi.	.....	Bamkana.	Do.	.....

MONSOON.

Pennisetum parviflorum (broad leaved).	Lapetawah.	.....	Chielawa.	Katta.	.....	.....
Eriochloa polystachia (narrow leaved).						
Panicum flavidum.	Bowri.	Dhanera.	Oda.	Kangna.	Chikwi.	Young mye thi.
Eracrostis elegantula.	Bhulani.	Asara.	Kodaipul.	Kheti.	Cutchabajra.	.....
Sporobolus diandra.	Chiria-ka-dana.	.....	.....	Nanak.	Ghorla.	Myet Kha.
Not known.	Muchmuchawa.	.....	.....	Kher.	Rahia.	.....
Anthisteria Scandens.	Ganer.	Gandhel.	Ramalchipillan.	Gandhi.	Gondial.	Myet ye Gei.
Eragrostis interrupta.	Rasaura.	Khujusia.	Urenki.	Lumra.	Lal Buli.	.....
Eleusine flagellifera.	Chauhel (Chimbar).	Jira.	.....	Do.	Chipa chima gadi.	.....
Imperata Arundinacea.	Ullu.	Usar ke ghas.	.....	Sandua.	.....	.....

The following are perennial, but altogether inferior grasses as fodder :—

Eragrostis cynchroides.	Kusa.	Devolia.	Durbha.	Dab.	Dabhat.	Young Bow Myet Gei.
Saccharum arundinacum.	Sarpat.	Shur.	Sarghas.	Sarkarda.	.....	.....
Phragmitis Roxburghii.	Narkat.	Nal.	Naga Sara.	Naisal.	Paika Gadi.	.....

Grasses.

There are some weeds which make excellent fodder, especially when mixed with other grasses, and also when made into hay. The best of these are known as—

Jhalmalawah,
Tinpatia.

Janewah.

There are at least seven known kinds of *janewah*, of which the best is *Lantanawa Janewah*. It is regarded by the natives of India as the best grass in the country. The other varieties do not differ to any great extent from the *Lantanawa* variety, and are all good fodder grasses with the exception of *Usar Janewah*, which is only a middling grass, and grows, as its name implies, only on *usar* or inferior land. *Janewah*, when cultivated, yields an abundant crop all through the year, and, if irrigated, will give as good an outturn as *dub*. It will grow, if allowed to, on manured land to a height of 5 or 6 feet with a coarse stem, but no careful farmer will allow it to attain this height. He will cut it, as previously explained in the chapter on harvesting, to encourage a greater growth of foliage and finer stem. It is a sweet, succulent and nutritious grass readily eaten by horses and all kinds of cattle. Horses are particularly fond of it at the season of the year (commencement of the monsoon) when the *dub* is young and has a bitter taste. Horned cattle prefer it at any time to *dub*, and it is a particularly valuable fodder for milch and other horned cattle. It can be issued as green grass direct; sweet scented hay of the best quality is made from it, and it makes excellent silage. *Janewah*, when uncultivated, is somewhat dry, and does not grow so abundantly as when cultivated, nor has it such heavy foliage.

Anjan (Ceterea glauca).

This also is a succulent grass with plenty of leaf, and when cultivated yields perhaps the heaviest crop of any Indian grass. It is liked by all animals, horses as well as cattle, though it is sometimes thought inferior when allowed to grow too high and coarse. It grows in tufts to a height of 4 or 5 feet and is indigenous to black-cotton soils and sandy loams. It is a good fodder in its green state, and makes very good and leafy hay. For silage, it is even better than *janewah*, being only inferior to it in its green state. It germinates more quickly from seed than any other grass, and is a good milk producer when fed to dairy cattle. After a few years it grows into large tufts somewhat like guinea grass. The growth of the grass is improved if these tufts are cut down level with the ground every second year. On trenched land it will yield seven to eight crops annually. There are two kinds of *anjan*, that with the dark and rough flower being superior to that with the hairy flower.

Dub.

Dub is the most popular grass in India. It is certainly far the best for lawns and is an excellent fodder grass. It is appreciated on account of its low growth, leafy foliage, and fineness. It grows anywhere—in swamps, on roadsides, in drains and on banks, but of course only scantily and spreading along the ground. The stem is jointed, and each joint will take root. For this reason the seed of this grass is seldom sown, it being merely necessary to chop the grass up into lengths of 2 or 3 inches, which, when scattered, take root. In its wild state it spreads along the ground and produces a less outturn than any other grass, and as it then grows to a height of only 6 or 8 inches, it must necessarily be kept for the hay crop, so that it may be cut by the *kŭrpa*. It is obvious that it would not pay at this height to cut it with any other implement, as the expense for cutting would be great and more than half the crop would be left on the ground. As previously explained the *kŭrpa* should not be used during the rains, so the issue of the grass in its green state is practically impossible. *Dub* should not be sown by itself on unmanured land, for, as above explained, it will not pay. At Allahabad when grass-farming was in its infancy, Sir Herbert Macpherson made an experiment of ploughing and sowing good arable land with *dub*. This entailed a very large outlay, but owing to the land not being manured the outturn was insignificant the first year. A similar outturn would have been obtained the second year, but for the fact that a number of other grasses, such as *janewah*, *khar-makra*, and a few other monsoon grasses made their appearance, which affected the outturn considerably. The experiment was never repeated as the results were so unfavourable. Even with light manuring the results are not favourable, as the crop is not remunerative till the indigenous grasses have sprung up. When cultivated, however, it grows upright to a height of from 2 to 2½ feet, and produces from six to eight crops annually, and with irrigation even as many as ten crops. The total outturn varies from 600 to 1,000 maunds per acre. *Dub* gives the best return when the land is

Photo-Block. Survey of India Offices, Calcutta, 1902.

A stack containing 3,500 maunds of grass, nearly finished. Showing the ramp with uprights and track made of sections of small bamboos.

trenched. It can be cut during the monsoon with either the *jhabau* or scythe, and can be either issued as green grass to horses and cattle, or made into silage. During this period, especially the first month of the monsoon, it has a bitter taste, and is not relished by animals; in fact horned cattle do not like it so much as other grasses at any time. It is therefore a good plan in the early monsoon to silo it. As far as possible *dub* should be issued green throughout the year. If this cannot be done, and it is desired to convert it into hay, it is advisable to mix it with other grasses. Great care should be exercised in cutting it when at the proper height, as being a thin-stemmed grass, it is easily blown down, and then quickly rots, or the stems at the bottom become discoloured and burnt up, in which state horses have been known to refuse it.

Musél. This is a grass which is found chiefly on black cotton soil. It likes moisture and flourishes from the middle to the end of the monsoon. There are two species of *musél*, *viz.*, one scented and the other unscented, the latter being the more appreciated by cattle. It grows from 3½ to 4 feet in height with a fine stem well furnished with leaves. It is best disposed of as hay on account of its heavy foliage, and also because, growing late in the rainy season, as it does, it is still green when the hay season commences. It is perhaps the best grass for hay-making in India, and is liked by horses and other animals, though in its green state it is not so readily eaten by cattle as *dub*, *janewah* and *anjan*, but at the same time it forms wholesome and nutritious green fodder. Cattle sometimes do not care for the scented variety, which chiefly grows on land containing excessive moisture, and therefore it is advisable to keep this grass for silage or hay. Both varieties make excellent silage. As many as three cuttings are obtainable of this grass from manured land. On rukbs or unmanured land only one crop may be expected, which, as above explained, should be made into hay.

Jargah. This grass grows only in the monsoon, except when irrigated. It is somewhat similar to *janewah*, to which it is inferior, but is a good fodder grass for all animals. It grows from 4 to 5 feet in height, is usually much mixed with other grasses and is seldom found on unmanured land. The leaves of the grass are not so plentiful as in *janewah*, while the stem is coarser; when young or from 2 to 3 feet high it is suitable for issue as green grass, after which it is best converted into silage or hay. It is not advisable to cultivate it separately, as it grows best with other grasses.

Siuri. This is an excellent monsoon grass, and grows only on rich or manured soil, and especially on land which has been top-dressed. It makes its appearance early in the monsoon and grows to a height of 3 feet; in appearance it resembles *dub*, but the stem is coarser, and the joints are at greater intervals. It is plentifully provided with leaves, and is an excellent fodder for horses, milch cows, and cattle, and it also makes good silage. It is a weak-growing grass, and is, therefore, usually found mixed with other grasses which tend to support it. It should not be allowed to grow too high or it is apt to fall over as its stem, though coarser than *dub*, is fine. It does not yield a very high outturn, nor, even with irrigation, does it grow well after the monsoon is over. Horses and cattle appreciate it best when issued green at a height of 1½ to 2 feet. It makes the best silage when approaching maturity. It makes good hay when the season admits of its being made in time, that is to say, when the monsoon terminates early; but when hay cannot be made till late in the season, the hay is somewhat inferior owing to loss of colour and foliage.

Parbah. This grass is commonly known as spear grass from its spear-shaped seeds, which, when the plant is ripe, fall off, and are liable to injure the mouths of horses and cattle. It is unpleasant to walk through a field of this grass when fully ripe as the spears penetrate the clothing and flesh in great numbers. It is solely on account of the seed that this grass has obtained such a bad reputation among Europeans. If, however, the grass is cultivated and is cut before the seed has ripened it is one of the most nutritious grasses in India. The Native Cavalry fully understand its value and feed their horses largely on it. It yields a very heavy outturn, perhaps larger than any other grass. In Allahabad on top-dressed land as much as 1,000 maunds per acre have been obtained in one year from several cuttings. It will grow, if allowed to, on manured land to a height of from 5 to 6 feet, while on unmanured land it will reach a height of from 3 to 4 feet. The effects of manuring are more noticeable on *parbah* than on any other grass. In its uncultivated state its stem is thin and woody, its leaves rough.

and it contains little moisture or succulence. When cultivated by either the top-dressing or night-soiling systems and cut frequently, the stems are thicker and more numerous, and the leaves more plentiful and soft to the touch and the grass is very succulent. The ordinary outturn of this grass when uncultivated is about 120 maunds per acre. It may be useful to know that land overgrown with spear grass when trenched or *heavily* top-dressed does not yield a single blade of it, it being replaced by other and deeper rooted grasses. This would seem to show that spear-grass is by no means a coarse or deep rooted grass. It is best to issue it green before the seed ripens, when it is both sweet and succulent. It is good for silage even after the seed has formed, as the spears become soft and do not injure the animal's mouths, but when over ripe it makes inferior silage. Uncultivated spear-grass makes very fair hay, if cut while the pollen is falling and before the seeds ripen. If, however, it is impossible to make hay before the spears have formed, it is advisable not to cut the grass till after the seeds have fallen, though of course the hay will not be nearly as good then as if cut in due season. Cultivated spear-grass makes excellent hay, as owing to repeated cuttings during the monsoon the stems become finer and the foliage thicker. It then usually grows with other grasses, in which state it makes better hay than when alone. When hay is made of coarse spear grass, it is advisable to chaff it before issue. This is one of the few grasses that should be grown from seed, as it germinates very quickly.

Khar-makra. This is a monsoon grass which grows chiefly on rich soil along with other grasses. It attains a height from 1 to 2½ feet. It yields only a light crop, and is easily ousted by other coarser grasses. It is reckoned among the best of the monsoon grasses and makes excellent fodder for all animals. Land manured under the top-dressing system produces this grass in abundance, while it is rarely found on trenched land. It germinates quickly from seed. It is best disposed of in its green state, when it is succulent. It makes, however, good silage, but inferior hay for the same reasons as all other monsoon grasses.

Sewain. This also is a monsoon grass of about the same quality as *khar-makra*. It grows chiefly on rich soil, on which it attains a height of 3 feet. On poor soil, however, it grows only a few inches, and is not worth cutting. This grass gives a heavier outturn than *khar-makra*, while cattle, specially milch cows, prefer it to most grasses. It is a good milk-producing fodder at all times. The natives collect the seed, which, when boiled, forms a good food. *Sewain* either grows alone or mixed with other grasses, and is best disposed of as green fodder or silage. It makes fairly good hay, when cut in time.

Sanwah. This grass somewhat resembles *sewain*, but its leaves are larger, its stem thicker, and the grain or seed also larger than that of the *sewain*. It is also nutritious, though it contains considerably more moisture than most other grasses. It grows only on rich soil, and produces a very heavy crop. It is best cultivated along with other grasses, and attains a height of 4 feet, if not cut sooner. It is advisable not to allow it to grow too high and coarse. It is best disposed of as green fodder and silage, but does not make good hay owing to its excessive moisture and coarseness, and also because, like other monsoon grasses, it is apt to deterioriate before suitable weather for hay-making sets in. Even when kept back by cutting it is not advisable to make hay of it. Horses thrive on it in its green state and it is liked by all cattle. The grain is also eaten by the natives.

Bhanjura. This grass commences to grow even later in the season than *musél*, making its appearance usually late in the monsoon, and is above ground only for six or eight weeks. It attains a height of 7 feet, and only one crop is obtainable from it. It is a good fodder grass, but has little foliage in comparison to the stem, which latter is somewhat woody. It is neither very succulent nor nutritious, though when cut young horses and cattle eat it greedily. It is best issued as green fodder, as it yields a light crop owing to its having no good bottom. It also makes very fair hay if cut in time, but if too mature it is inferior owing to its woody stem. It can be siloed ; but as it is in bloom about the hay-making season it is perhaps best disposed of as hay. It is ready for cutting about the end of the monsoon, when no time should be lost in harvesting the crop. Horses are partiularly fond of the flower.

Photo-Block. Survey of India Offices, Calcutta, 1902.

The *phaurah* and hay-knife.

Grasses.

Chuprailа. This is a monsoon grass and grows to a height of from 2 to 3 feet on very rich soil only, especially on land manured by the top-dressing system. It yields a heavy crop, but is best cultivated along with other grasses. It is succulent and nutritious, and suitable for all classes of animals, especially milch cattle. Its broad leaves are sometimes considered an indication of inferior grass, but this is by no means the case, as it has been proved by experimental feeding to be an excellent fodder grass. It is best issued green or siloed for the same reason as given for other monsoon grasses. No doubt if it could be cut young enough it would make fairly good hay, but even then owing to its excessive moisture, it would not be advisable to make hay of it. The grain of this grass is eaten by the poorer classes of natives.

Makraila. This grass somewhat resembles *makra*, a cereal, hence its name. It grows with other grasses usually, being sparsely distributed and on rich soil. The stem is rather tough, and is therefore not much appreciated by horses and cattle when fed to them unmixed with other grasses ; but it is a good fodder for cattle. It does not usually grow higher than 2 feet. Owing to its toughness it does not make good hay, and is best disposed of as green fodder or silage.

Bharwi. This is a grass which grows abundantly in Bundelkhand and the Central Provinces. It resembles guinea grass in appearance, and, if allowed, will grow to a height of 8 or 10 feet. It grows best on rich soil, when it puts forth a great deal of leaf. On poor land it is chiefly stem with little foliage. This grass produces an abundant crop, and is usually ready for cutting before any other grasses. On manured land without irrigation it yields from eight to ten crops annually. *Bharwi* should be cut young at a height of 4 or 5 feet, as frequent and repeated cuttings produce a thicker growth of foliage and less and finer stems, in which state cattle prefer it as it is soft and succulent. When chaffed this fodder is much relished by cattle, but should be sparingly fed to milch cattle, as, like guinea grass, it is somewhat heating. It does not make good hay alone, but may be made into hay when not more than 3 feet high, along with other grasses. It makes first-rate silage. *Bharwi* grows in tufts, which require cutting level with the ground every second year. This grass growing quickly to such a height spoils the park-like appearance of trenched lands, and should therefore be grown alone, especially as it spreads quickly and tends to retard the growth of other finer grasses. It should always be uprooted from *dub* grass lands, before it flowers. There are two kinds of this grass, one of which is somewhat inferior.

Ganér. This grass is often mistaken for *bhor* (see below.) It has more leaf foliage and makes much better hay. It also makes good silage and can be issued green.

Sén. This is an excellent grass and grows largely in Bundelkhand. It is perhaps best issued when cut as green grass, or can be made into silage. It, however, makes good hay when cut in time. Horses and cattle alike are fond of it.

Bhoru. This grass is also indigenous to Bundelkhand and Central India. It is a fairly good grass when green and young. It is usually made into hay, which is somewhat inferior owing to its tough stems and scanty foliage. It makes good silage. Horses like it best when mixed with other grasses. It attains a height of 5 or 6 feet on rich soil and is of a brownish red colour.

Lapetawah (1) Broad-leaved variety. This is a monsoon grass. The broad-leafed variety is the better of the two. When cut green or siloed, it makes good fodder for all horned cattle. It is, however, not a suitable grass for horses unless mixed sparingly with other grasses. There is usually no difficulty about this, as it only grows sparsely among a variety of other grasses. It attains a height of 4 or 5 feet, and is easily recognizable by the flowers, which, when ripe, cluster together and cling with tenacity to clothing like the ' burr.' It is not suitable for hay.

Lapetawah (2) Narrow-leaved small variety. This is a somewhat inferior grass and should, as far as possible, be only fed to horned cattle. It is found in abundance under the shade of trees, and seldom grows on poor soil. The flower is not like that of the broad-leafed variety, and does not adhere to the clothing. It grows on rich soil sparsely mixed with other grasses for the first few years after manuring, when it is gradually ousted by otner grasses. It is not very nutritious, and does not make good hay, but is a fairly good fodder for horned cattle as green grass or silage.

Grasses.

Bowri

This is also a monsoon grass, and like *lapetawah* grows sparsely on rich land, and is also frequently found under the shade of trees. It is superior to the small variety of *lapetawah*. Horses will eat it green, but it is more suitable for horned cattle. It grows to a height of 2 feet and does not make good hay, because, like all monsoon grasses, it has usually withered before the hay-making season. It should therefore be disposed of green or as silage.

Bhulani.

This is a light feathery grass which chiefly grows on arable land recently put under grass. It has not much substance and is not very succulent, although cattle eat it greedily. It grows only about one foot high, and is therefore best disposed of as green grass. It is too short for silage, but makes fair hay when mixed with other grasses. After the land has been under grass for about two years *bhulani* disappears, giving place to superior grasses.

Chiriaka dana.

This grass is almost identical with the above species in all respects, except that it makes very poor hay.

"Muchmuchawah."

This is a monsoon grass which grows in small tufts to a height of from 8 inches to 1 foot, and on poor soil does not exceed 6 inches in height, when it is hardly worth cutting. It is best made into hay, as if issued green or as silage it would be necessary to cut it with the *kŭrpa*. When made into hay along with other grasses among which it grows it is difficult to avoid cutting in tufts. It makes a passable fodder and is eaten by horses as well as cattle.

Motha.

There are some four or five kinds of *motha*, of which one is known as the large species, and grows in swamps and ponds and attains a height of 5 feet. The remaining kinds only vary from each other as regards the flower, and are all small, growing to a height of 1 or 2 feet. One of these small varieties grows abundantly with *dub* on lawns or trenched lands and, in time, ousts the *dub*. This is the best variety, and its roots are found to a depth of 15 feet in the ground. This root resembles a thread with small black bulbs at intervals. This variety is that mentioned by General Ottley, who experimented some years ago on the cultivation of *dub* by the trench system. He endeavoured to eradicate this grass by sifting the earth through a sieve with a view to picking out the bulbs and threads when preparing the land for *dub* cultivation. This experiment proved a failure, as it was found that the *motha* appeared as abundantly as ever after a few years. In the case of a lawn it is necessary of course to weed out this grass, but in grass cultivation it is not necessary, as when mixed with other grasses it is not considered inferior, and if the grass is frequently cut, as explained in the chapter on cutting, the *motha* can be kept down and will not impede the growth of the other grasses. *Motha* grows heaviest throughout the monsoon, during which season it should not be allowed to grow too high, as besides interfering with the growth of other grasses its leaves soon become discoloured, in which state it is only fit for silage. When young it is best issued green with other grasses, as it then contains too much moisture to make good silage. It is not suitable for hay. When issued green it is readily eaten by horses and cattle, and forms a fairly good fodder when mixed with other grasses, but it is not much relished when fed alone owing to its bitter flavour. The large variety is not fit for fodder, except for horned cattle in the form of silage, and then only when mixed with other grasses.

Lapa.

This grass grows chiefly on poor soil, and is a poor description of fodder. It is a delicate grass possessing little leaf foliage and fine stems, and is easily ousted by other grasses when the land is manured. It yields a very poor outturn, and grows from 6 inches to 2 feet in height. Horses and cattle will eat it when young, but it contains little nutriment. When mature, cattle refuse it owing to the spear-like seeds somewhat similar to but much finer than that in spear-grass (*parbah*) which hurts their mouths. It is best siloed and issued green, mixed with other grasses. It appears abundantly on poor land when first taken up for grass cultivation, and in order to eradicate it the crop should be burnt before the seed has ripened. As already explained, it will disappear when the land is manured. *Lapa* has been made into hay along with other grasses, but it is apt to spoil the hay on account of its spears which cannot easily be got rid of.

Ginrar.

This grass grows chiefly on swampy land or any soil which contains excessive moisture. Its roots are known as "*khas khas*" and are used for making *tatties*. They have an

Photo-Block.

Survey of India Offices, Calcutta, 1902.

The Scythe.

agreeable aroma. The grass itself, when ripe, is used chiefly for thatching. Its stems are utilised in the ryots' homes for making the brooms used in connexion with the grinding of grain and flour manufacture, and also for making native sieves (*chalunies*). When cut young it is readily eaten by all cattle, and even horses. It makes excellent silage, and, when made into hay *and chaffed*, is good fodder for all animals, but unless chaffed, it is hardly edible, as it is too coarse. At Allahabad some 15,000 maunds of this hay were condemned owing to the hay being too coarse, but as an experiment the late Sir Herbert Macpherson ordered it to be chaffed, in which state it was consumed by horses and cattle with the best results.

Kansa. This grass also likes moisture, and on good rich land it attains a height of 8 feet. On ordinary land it only grows to a height of 4 or 5 feet. It is also occasionally found on dry soil. This is known as the cultivator's enemy, as its roots go down to a great depth and form a tangled mat below the surface. It is, therefore, very difficult to eradicate. It has a round stem like a reed and is jointed like sugarcane. Its flower is white and fluffy, and about the beginning of September, when the grass is in full flower, it presents a very pretty appearance, especially when the wind blows and the ground looks as if covered with white waves. This grass is generally considered one of the worst; but the idea is erroneous, at least as far as the young grass is concerned. Professor Wallace took a sample of this grass home to England with him in 1887, and after analysis pronounced it among the most nutritious grasses in India, and as belonging to the saccharine family. Experience has also proved that this is a good fodder grass if harvested in proper time. Owing to its bad repute it is usually issued as bedding to cavalry and artillery horses, but it is always complained of by the regimental officers owing to the horses eating it up,—a pretty good proof that it is not a bad fodder even for horses. The first crop when cut too young is somewhat heating, and is apt to purge the animals fed on it; while, on the other hand, if cut when mature and the flower has formed, it is too hard, and should be made into hay mixed with other grasses. It is best cut just before the flower appears, and if chaffed is readily eaten by all animals either in the form of green grass or converted into silage, in which state it will not cause purging. After the first crop has been cut, the young shoots which appear make excellent and nutritious green fodder and should be cut and re-cut when low. This grass should never be grown separately but along with other grasses, and if frequently cut, as above described, the stems will be fine and tender. *Kansa* grown on manured land produces an abundant crop with much foliage and fine stems. Owing to the prejudice against it, its growth should not be encouraged, but where it is already in existence endeavour should not be made to eradicate it,— a very expensive operation. If, however, for the sake of appearances, it is necessary to eradicate it, the best method is to trench the land and sow *dub*, which will rapidly oust the *kansa*. To prevent the spread of *kansa* it should never be allowed to flower, or its seed will be scattered far and wide by the wind. *Kansa* when mature makes fairly good rope, known in the vernacular as *badh*, and it is excellent for thatching, as it is seldom attacked by white ants. *Kansa* can also be partly ousted for a considerable time when land is required for crop cultivation by ploughing and sowing a crop of hemp, which, when it has attained a height of 4 or 5 feet, should be cut down and allowed to rot on the land, and subsequently ploughed into the soil. It is useless and expensive to attempt to eradicate *kansa* by digging deep down and taking out the roots, as these go down to a great depth, and many of them must be left; so that the *kansa* soon re-appears. It may happen that land recently taken up for grass cultivation, and originally either cultivated or closely grazed, will show no signs of *kansa* on it; but after it has been preserved for a couple of years the *kansa* rapidly makes its appearance. This shows that constant cultivation or grazing tends to keep the *kansa* down, and therefore the best course is to encourage the growth of other grasses. This can be done by either trenching or top-dressing, in which case constant cutting of the crop as previously described is necessary. This will keep the *kansa* down several years, while the land will yield heavy crops of superior grasses.

Kazaura. This is a grass that commences to make its appearance about the middle of the monsoon, and grows chiefly under the shade of trees and on low-lying and, therefore, moist land. It has very little leaf foliage, and chiefly consists of a single stem. It

bears a long pink or brown fluffy flower and its stem tastes somewhat sour. It grows sparsely, mixed with other grasses, and is eaten by all cattle in its green state, and makes, along with the other grasses with which it grows, fair silage or hay, but it should not be fed in large quantities to horses.

Chauhel (Chaimbar.) This is a grass which in appearance somewhat resembles the familiar *dub*. It is a better grass than that last described, and, like it, grows sparsely among a variety of others. It appears shortly after the commencement of the monsoon, but does not grow to any height, being low and bushy and jointed like *dub*. It can be issued either green or made into hay, in which case it must be cut with the *khŭrpa* owing to its shortness. Horses and cattle do not eat this grass very readily and it is best siloed or issued green.

Raghai. This is a perennial grass and grows in tufts. It makes excellent rope (*badh*), which sells readily at Rs. 4 per maund. Bullocks and buffaloes eat it when it is young, but it pays better to dispose of the crop for rope-making or to utilise it for making the ropes required for thatching and building purposes on the farm. It is a hardy grass and grows abundantly on manured land. On a large farm it pays to keep a few acres of land entirely for the cultivation of *baghai*. It is usually cut at a height of 3 or 4 feet before it flowers.

Ulla. This is a monsoon grass found usually in swampy land, river-beds, etc. It is also found in ravines owing to its seeds being brought up from the river-bed in the monsoon, when the river rises and floods the nullahs and adjacent land. This grass is readily distinguishable, as it grows only to a height of 1 foot to 1½ feet, and bears a white fluffy flower. It grows very thickly, and the ground presents a white appearance somewhat similar to *kansa*, though the grass is much shorter. It is not a very succulent grass, though it carries much foliage and is eaten by horses and cattle when young and before it flowers. It makes inferior hay and silage, and its growth should be discouraged, as it is not a profitable species to cultivate. If allowed to grow with other grasses, it will soon oust them. All land overgrown with this grass should therefore be either trenched or top-dressed.

Bhamani. This grass grows throughout the year and attains a height of from 5 to 6 feet. When young and green it is eaten by horned cattle, but is not very succulent and is too coarse for horses. It also grows on moist land, and is largely used by fishermen for making the ropes used in their boats. It is not a grass to be cultivated, and is, moreover, easily ousted by encouraging the growth of finer grasses.

Karia. A grass which grows from 3 to 4 feet high on fairly moist land. It grows abundantly in the Central Provinces and Bundelkhand. Though not a first class grass, it makes good hay when cut in time and is suitable for horses and cattle. It also makes very good silage, as cattle relish it more in that state than when issued green.

Gén bandari. This grass appears only on rich soil during the monsoon and mixed with other grasses. It grows to a height of 3 feet and bears a hairy flower about 2 inches long with small round white seeds clustering round the stem. The flower grows straight up. All animals eat it when green, but it is suited for horned cattle either as green grass or silage. It does not make good hay, as it dries up before the hay-making season commences.

Kúsa. This is a somewhat inferior grass with flat and closely-jointed roots projecting far down into the ground and forming a tangled mat below the surface. It is, therefore, very difficult to eradicate and, as in the case of *kansa*, it makes its appearance quickly on grass lands previously under cultivation or closely grazed. It grows on unmanured land to a height of 2 feet, but if the land is manured it will attain a height of 4 feet. Its leaves are long, broad and coarse, while the flower, which is about a foot in length, is of a brownish colour, with numerous spikelets. Horses are particularly fond of this flower, which appears between April and June, and is really the most nutritious part of the plant. When grown on manured land its leaves are finer and more plentiful. Attempts have also been made to eradicate this grass by deep excavation, but with poor results. It should be eradicated in the same manner as *kansa*. It is eaten by all cattle and even by horses, when cut young and chaffed, and mixed with other grasses it makes good silage. It can also be made into fairly good hay when largely mixed with other grasses but even then it will require chaffing.

Photo Block.

The Tedding machine ready for action. The mule saddle shown is a Commissariat pack saddle.

Grasses.

Sărpăt. This grass can hardly be classed as suitable for fodder, though when young and tender animals graze it. It is, however, largely grown as a fence, and is useful on top of boundary banks to prevent the earth from slipping. It is also used for thatching hay stacks and temporary huts, while the reeds when bound together make a rough rope which answers the same purpose as bamboos. It grows to a height of 10 or 12 feet and bears a flower 3 feet long. Before the flower makes its appearance the *moonj* or envelope of the flower and upper portion of the stem can be cut or broken off, and forms a very valuable product, which is largely used for ropes and string, which again are converted into mats, well-ropes, etc., or used for thatching. The rope is specially valuable for that portion of the well-rope nearest the *chursah* or water-bag, as well as for general use in the rains owing to its peculiar power of resisting damp and its durability under moist conditions. A species of rough paper is also manufactured from the *moonj*. If it is desired to use this grass only as fodder, it is advisable in the summer to burn down the grass which, when it sprouts, will bear chiefly edible foliage with little reed. It is also useful in the reclamation of barren land.

Narkat. Is an inferior grass which is only edible by cattle when quite young. It has a stem like a pea-shooter and grows to a height of 10 or 12 feet, and is used by the natives for making pens.

Sŏnta. This may be classed among the most inferior grasses in India. It consists of a number of long stems with little or no foliage. Great care should be taken to prevent the growth of this grass and on no account should it be allowed to seed. Grass land over-grown with it should be repeatedly fired.

Paspalum Dilatum. The experimental cultivation of this grass has only just begun in India. When irrigated, it yields an abundant crop of luxuriant grass with much leaf foliage. All animals eat it greedily and thrive on it. It is not yet known whether it will withstand the drought and hot weather of India without irrigation. It makes excellent fodder for milch cattle and can be propagated either from seed or roots.

In addition to the grasses above described there are several plants commonly called weeds which are good fodder for both horses and cattle, and make a good bottom for a hay crop. Among these are—

Jhalmalawah.	Dudhia.
Tinpatia.	Lahesawah.

Jhalmalawah. This is a very nutritious weed. It grows along the ground, has very small leaves and bears a pinkish flower. Its stem carries, along its whole length in little clusters, numerous bunches of small pods containing seeds. It is the pods that make horses so fond of this plant which they pick out from the hay. It is ready for cutting at the same time as the hay crop is usually harvested, and is best disposed of along with the hay.

Tinpatia. This plant somewhat resembles clover, and like Jhalmalawah it mixes well with hay and is fit for cutting about the same time. It is believed by many to be the shamrock.

Dudhia. This is a small plant which grows to about a foot or less in height. It has clusters of seeds or flowers at intervals along its stem, and carries but little foliage. It is much appreciated by buffaloes and milch cattle when green.

Lahesawah. This plant grows to a height of 4 or 5 feet with a large pink and white flower, some 4 inches long, containing numerous small black seeds. It carries a quantity of foliage in the shape of broad leaves, and when young is a succulent fodder for milch cattle, if mixed with other fodder. The natives of India cultivate this plant mixed with others for feeding to milch and working cattle. It grows abundantly with the *kharif* crop. There are several of these weeds which cattle will eat, but they differ according to districts.

There are certain other weeds, such as *pathari*, *hurur* and *madar* (caustic plant), which should be pulled up and used as manure, as they are unfit for fodder, but all other weeds can be cut along with the grasses and converted into silage, as cattle will eat them readily, though they might refuse them in a green state. The foliage of some trees makes good fodder for cattle, especially that of the plum (*bér*) and *babúl*.

During recent famines in India, the unfortunate cultivators in the famine-stricken tracts were obliged to resort to feeding their cattle on leaves of trees, and thousands of animals were thus saved from perishing.

CHAPTER XIX.

Cultivation of Crops.

It may be argued that the cultivation of crops has no concern with grass farming. This is by no means the case, as grass farming surely includes the production of green crops and grain which form such an excellent fodder at seasons when green grass is not obtainable. This fodder is very beneficial to the animals as a change, and considerably lessens the usual difficulty in providing sufficient fodder for all the Government animals in a station, and which is partly due to the outturn of crops being far heavier per acre than that of grass, especially in the case of the *kharif* crop, of which *karbi* or *juar* forms the chief and best part. The *rabi* crop, too, is harvested outside the grass-cutting season, which is another argument in favour of crop cultivation. The growing of grain crops for sale in the open market is not here advocated, and might legitimately be objected to as outside the range of grass or fodder farming. If crop cultivation was not allowed, the *kachar* or alluvial land which so frequently forms a part of the cantonment lands would be almost valueless, as no grass could be expected off it during the monsoon, when the ground is under water. When the water subsides it is true that some grass will be obtained, but the quantity would be very small compared with that to be expected from *rabi* crops.

It is advisable to set apart certain suitable lands for the cultivation of crops, whether *rabi*, *i.e.*, sown about October and harvested in the hot season, or *kharif*, which is sown at the commencement of the monsoon, say about June or July, and harvested at the end of the monsoon, or say, about October. The reason for the necessity of retaining certain lands for crops is that time, labour, and expense would be lost in transforming the land from grass to crop cultivation.

Kharif. The *kharif* crops are generally those most suitable for fodder. The following are among the best for this purpose :—

Sorghum vulgare— or juár.
Sorghum— (American) Imphi.
Sorghum Pencillaria spicata— bajra.
Sorghum zea—maize— Makai (Indian-corn).
Carrots.
Guinea grass.
Lucerne.
Phaseotus radialus—moth.
Phaseolus mungo—mung.
Eleusina corocana—makra.

Rabi. Of the *rabi* the following are the most important for fodder purposes :—

Green oats.
„ barley.
„ wheat.
„ peas.
„ vetches (akra).
„ senji.
„ maina.
„ sarson (mustard), light coloured.
„ rai („), dark „
„ senwah.

Sorghum vulgare or juár. Juár is an excellent fodder for all animals, especially for horned and milch cattle. When grown for fodder 24 pounds of seed per acre will suffice, and about 10 pounds for grain. By growing it thickly for fodder the stems are finer and the foliage more plentiful than if grown sparsely for the grain.

Photo-Block.

Survey of India Offices, Calcutta, 1903.

The Rake. The trip action applied. Observe the light saddle on the mule.

Cultivation of crops.

The ground is prepared for this crop early in the monsoon, and the land selected for the purpose should be a loamy soil, and yet not too low-lying, as if there is too much moisture in the soil the crop does not flourish. In order to produce a heavy and succulent crop, it is necessary that the land should be well manured, and this should be done during the hot summer months. A top-dressing of town rubbish, either long or short, as explained in the chapter on top-dressing for grass cultivation, is suitable for the purpose. If long manure is used it should be put out on the land at least two months before the commencement of the monsoon, while short manure may be put down immediately beforehand. Another good and very economical method of manuring for any of the *kharif* or *rabi* crops is that described under the heading of stock manuring. Night-soil manuring is also good. One of the advantages of manuring is that the plants sprout quickly and grow in advance of any weeds which may be lying dormant in the soil, and less weeding with its accompanying expenditure is necessary than if the crop had been sown in unmanured land. Of course some weeding may be necessary where weeds grow in advance of the crop; or, in fact, appear to obstruct its growth. In most cases, however, it is preferable to let the crop and weeds grow together till the former has attained a height of about 5 feet, and then cut all together and issue green after separating the weeds, or better still silo the whole together. If the season is favourable, another good crop may be expected with a far smaller proportion of weeds, though there may be a good bottom of mixed grasses. If, however, it does not seem probable that a second good crop will be obtainable, then it is preferable to leave the sorghum until the flower has appeared and the grain is commencing to form, at which stage it will be at a height of from 10 to 12 feet, according to the richness of the soil. The plant will then be at the best stage for green fodder. It may either be issued at once or dried and stacked in the same manner as hay, but if the latter course is adopted great caution is necessary in seeing that the fodder is perfectly dry before it is stacked. For milch cattle it is best issued green, and some little time before the flower has made its appearance. From 400 to 500 maunds per acre is about the usual outturn. *Sorghum* should be chaffed into lengths of not more than one-third of an inch before being fed to any animal, as otherwise there will be great wastage. When stacked and dried it is advantageous to issue it mixed with other green fodder, such as *mustard*, *rai*, *senwah*, *senji*, or *maina*. This admixture is more palatable than the dry fodder alone. After the *sorghum* has been harvested a small quantity of grass may be obtained from the land during the summer months by means of the *kŭrpa*. *Sorghum* of all kinds makes excellent silage—more especially when chaffed before being put into the pits. It is advantageous to sow *moth* or *mung* (about 4 lbs. per acre) with *sorghum* grown for fodder, which gives it a good bottom.

Sorghum (American).

This is somewhat similar to the *sorghum andropogon*, but it is sweeter and more relished by horses. It also gives more cuttings, and when irrigated as many as five or six cuttings have been obtained. It should be treated in the same manner as the *sorghum vulgare*, but it can be cut much earlier, as it matures much quicker. There is some danger of poisoning the animals fed on any species of *sorghum* which has been cut when only a few feet high after a long break in the monsoon. It is caused by nitrate of potash in the stems. After a shower of rain it is again safe to issue it. Animals which have been fed on the poisonous plant die very soon with symptoms resembling tympanitis; in some cases animals have died within 20 minutes of eating the fodder. An instance occurred on the Allahabad Farm when sheep which were hired for purposes of stock manuring, were at the request of the owner turned on to graze an aftermath crop of *sorghum vulgare*. Eight of the sheep died within a few minutes, and many more were saved merely by the rapid administration of purgatives. During lengthy breaks in the monsoon, when the *sorghum* thus becomes poisonous, owing very probably to the nitrate of potash accumulating in the stem, there is danger of grass-cutters bringing in some of the small plants of the *sorghum* when *chíling* grass from among the crops. At Allahabad, in the summer of 1896, a number of horses belonging to private individuals died from this cause. The season was an exceptionally dry one; in fact the monsoon failed and the crops being stunted and partially withered, the grass-cutters were allowed by the ryots to take grass from the *juár* fields.

Cultivation of crops.

Penicilleria spicata, or bulrush millet (Bajra).

This is inferior to the other kinds of *sorghum*, being somewhat heating. It is on this account necessary to mix it with other fodder before issuing it to milch cattle ; in fact it is best to issue it to cattle other than milch cattle. It is best issued green and young or as silage. It is sown after the *juár* crop or about the middle of July to the middle of August, and for grain 6 lbs. per acre and fodder 16 lbs. per acre. *Moth* should be sown with it.

Maize (Makai).

This makes an inferior fodder when fed after the cobs have ripened and should be fed only to working cattle, when mixed with other fodder. The grain, however, is very fattening, and where pigs are kept it is profitable to grow this crop. It requires a richer soil than any of the above-mentioned crops, and the best seed is that known as the *Jaunpuri*. This latter seed is superior to the American. It should be sown sparsely about one foot between each seed or about four pounds per acre, but it is often sown broadcast. If sown too thickly, the cobs will be small and the grain inferior. It is necessary to weed this crop and to heap the earth to a height of about 6 inches round each plant when it has attained a height of about 4 feet. This enables the roots to get a firmer grip and assists the plants to withstand strong wind. It may be sown immediately before the commencement of the monsoon, or if the monsoon is not delayed, it is better to sow after the rains has commenced. From 20 to 25 maunds per acre is considered a good outturn of grain. After removing the cobs from the stems the latter may be cut, chaffed, and issued with other fodder to all cattle, but if fed with the cobs and before the seed matures, it makes excellent fodder.

Country carrots.

These form a very palatable change for all animals, but should be cut up small and sparingly fed mixed with grain or other fodder. The seed is sown about the middle of August, and the crop commences to be harvested about the middle of January. Carrots require a moderately rich, light, sandy loam soil. If grown on too rich soil the plants run to stem and leaf and seed quickly, while the roots are very small. Carrots require to be well weeded, and the soil loosened to admit of the roots penetrating it. Carrots can be siloed, but so far in India the operation has not been attended with much success. They can be kept a considerable time by covering them with sand. Fifty maunds per acre is a good outturn.

Guinea grass.

This also forms a good fodder for all animals when mixed with other grasses. It grows in tufts to a height of 10 feet. The richer the land the more succulent and tender will the foliage be. It should be first cut when some 4 or 5 feet high, as if allowed to attain its full height it becomes too coarse for fodder. Subsequent crops should be cut at a height of 2 or 3 feet, as the oftener it is cut the finer will the fodder be and the greater the outturn. When well watered as many as twelve cuttings may be obtained annually, or some 1,500 maunds per acre. It will require manuring (top-dressing) every third year, and will not require to be re-sown for years. It should be sown in rows 2 feet apart and at intervals of 2 feet, and is best and quickest grown from old roots. After the second year the tufts should be split up and some of the roots removed. It is best issued as green fodder or silage, and the third or fourth crop makes fair hay. This crop may be grown with advantage on land trenched with sweepings, or even with night-soil. The ground must be kept free of weeds and the top surface kept soft.

Lucerne.

This crop requires a very rich, loose soil (sandy loam), as its roots penetrate to a good depth. It quickly impoverishes the soil, and therefore requires to be manured heavily every second year. The best time for sowing is in October after the monsoon is over, as the plants will then be strong enough to resist damage during the next monsoon. It does not thrive well in the monsoon when the roots frequently rot. It is sown in ridges 2 feet apart, somewhat thickly, and must be well weeded. This affords better protection to the plants from the rains than when sown in small level plots, a method preferred by many people. Trenched land is very suitable for this crop. It is a valuable fodder for horses and working cattle when given in small quantities with other fodder as a change, but except in very minute quantities it is not suitable for milch cattle, as it is too heating. It makes good hay.

Rabi crops ; green oats.

This is excellent fodder for all animals, especially horses. It is sown for harvesting green in the same manner as if grown for the barley crop, *i.e.*, about 100 lbs. per acre. A rich, moists oil is required for this crop. Attempts have been made to sow

Photo-Block.

The mowing machine showing how the shaft is connected with the yoke.

imported seed, such as Australian and Cape, but the former, though producing a large outturn of green fodder, has been found, in this country, to produce very little grain. The Cape seed has proved more successful, but on the whole the best results have been obtained from selected country oats from Tirhoot and other places. The seed is sown about October, and is usually ready for harvesting as green fodder in February or as oaten hay by the beginning of March, while if kept for grain it should be ready for the sickle about the middle of March. It is advisable, however, to harvest the grain in the ear as is universally done in Australia. When the land is very rich and moist or can be irrigated, it is possible to obtain two cuttings. In this case the first cutting should be taken when the crop is 2 feet high and before the flower has formed. The second cutting should take place when the grain is approaching maturity, *viz.*, when it is soft and milky. At this stage the fodder will be at its best, and there will be no risk of losing the seed during harvesting or when stacked, which would be the case if the crop were more mature. On the other hand, if harvested too soon, though the fodder will be succulent, there will be but little nutriment in the grain.

Harvesting oats.

The crop should be cut either by the mowing machine or by hand labour with the *jhabau*. Whatever implement is used, care should be taken that it is sharp, as otherwise a portion of the crop is uprooted instead of cut, and the earth adhering to the roots detracts from the value of the fodder. When cut it should be allowed to lie on the ground, and after a few hours' exposure to the sun carefully turned and the process repeated several times. If cut early in the day the fodder should by the evening be sufficiently dry for cocking. It must be handled as little as possible, or the grain will leave the ear. It should remain in the cocks for about six days, and then be carefully stacked. Prior to issue, the whole, including the grain, should be passed through a chaff-cutter. This fodder is largely used in Australia and in the Remount Department in India, and is considered very valuable for young horses.

Eleusina, corocana (makra).

This makes good fodder for cattle, and is used largely in the Deccan. It is sown at the commencement of the rains, about 10 lbs. per acre. It can be siloed or issued green when the seed is approaching maturity.

Phascolus radiatus (moth.)

This is an excellent crop, which cattle are very fond of and thrive on. It is perhaps best grown with juár (*imphi*) or grass. With the latter it makes a good bottom which improves the hay crop very considerably when sown with other crops ; 4 lbs. per acre will suffice.

Munj.

This is also sown with juár and makes good fodder. It is sown at the same time as *moth* at the beginning of the monsoon.

Panicum miliacum (sawan chaitwa).

This is sown in March, about 12 lbs. per acre, and if cut before the seed matures it makes fairly good fodder.

Panicum frumenticum (sawan).

This species is sown in the monsoon and cut in August, about 12 lbs. per acre. It makes excellent fodder, especially for milch cattle, and can be issued green or siloed.

Barley (hordeum vulgare) *Jau.* Wheat (triticum sativum) *Gehun.* Peas (various kinds) *muttar.* Vetches (various kinds) *Akra.*

These are best grown as a mixed crop and make very excellent fodder for horned cattle, though not so good for horses. The green wheat (*kasil*) grown alone forms excellent fodder for horses. As the crop is approaching maturity and when the grain is milky it should be cut, chaffed, and issued at once, as it is best relished when green, especially at a time (March) when green fodder is scarce and is very beneficial to cattle. It is a good milk-producing fodder and is almost indispensable for dairy cattle. It should be sown at the commencement of the cold weather, as if sown too early the shoots are nipped off by an insect known in the vernacular as the *katawah*. About 120 lbs. per acre is sufficient seed, of which one-half may be barley, 60 lbs. ; one-fourth wheat, 30 lbs. ; and vetches and peas, one-eighth each, 15 lbs. This crop should not, if possible, be kept for hay, as the vetches when old are apt to cause colic, unless it can be converted into hay at the proper state. Also when too old the barley hairs stick in the animals' throats, while the foliage of the peas becomes innutritious.

Gram (Cicu Ariatinum) *Channa.*

This crop is sown from the middle of September to the middle of October, about 80 to 100 lbs. of seed per acre. When grown with barley it makes excellent fodder, and should be cut before the grain is mature.

Feed and treatment of Government animals.

Senji. Maina. Sarson (yellow mustard). Rai (rape) Sennah.

These are all somewhat oily plants, and should be fed sparingly mixed with other fodder to horned cattle only. They are all sown about the same time, usually in October and harvested about February or March. All of these are best grown mixed with other crops, such as barley, oats, vetches, etc., about 3 lbs. per acre. The proportion may seem small, but the seed is minute and a pound contains a large number of seeds, and if grown too thick they will interfere with the growth of the other crops. *Senji* and *maina* are grown largely in the Punjab and fed green to milch cattle. If issued ripe they are liable to cause colic. These crops require rich and moist land, such as the alluvial land in the beds of rivers, and they should, if possible, be irrigated. *Sarson* and *rai* are both mustards, the former being usually considered the better as a seed. Oil is extracted from both kinds, but the *sarson* gives the larger grain and the clearer oil. They are especially good for dairy cattle. They grow to a height of 5 feet and should be cut before mature, as described in the case of other crops, but not until the pods are formed, as otherwise the fodder will be lacking in nutriment. In cases where the crops grown with these are reserved for hay or for the grain itself, it is usual to remove the mustard by hand and chaff it along with other dry fodder. It is thus rendered very palatable. This is necessary owing to the oil plant growing usually in advance of the others.

Senwah.

Senwah also requires to be weeded out by hand before the other crops are ripe, as it grows in advance of the crops sown with it; indeed it is generally sown early, along with the gram crop. It will grow on almost any soil, but, unlike other crops, should be harvested before the pods form, as the pods are bitter and heating, and are especially injurious to milch cattle as they decrease the yield of milk.

Gram can also be grown like the above, cut dried, stacked and issued after chaffing without separating the grain from the leaf or pods. It is an excellent fodder in this state. There are also other crops, such as *til*, linseed, sugar-cane, turnips, potatoes, radishes, mangold wurzel and the various kinds of pulses (*dhal*), *viz.*, *arhar*, *oorud*, and *mung*; but as a rule it is not profitable to grow these except where pigs are kept, when some of the root crops may perhaps be cultivated with advantage. Mangold wurzels are very good for cattle and can be profitably grown on night-soil land.

CHAPTER XX.

Feed and Treatment of Government Animals.

Feed and treatment of Government animals and disposal of farm produce.

Besides providing sufficient fodder for animals, every precaution must be taken to adopt the best and most economical system of feeding, without due regard to which much wastage and loss will occur. The scale allowed by Government for all animals is given below:—

	Green grass.	Hay.	Bhoosa.	Green crops.	Silage.
	lbs.	lbs.	lbs.	lbs.	lbs.
Horses of British Corps . .	30	20	20	...	...
Horses of Native Cavalry .	30	20	20	...	...
Ponies of Native Cavalry . .	25	10	...	...	...
Mules over 13 hands 2 inches .	30	15	15	30	30
Mules under 13 hands 2 inches .	25	13	13	25	25
Yaboos	30	20	20	39	30
Siege train bullocks . . .	35	25	20	35	35
Army Transport bullocks . .	30	20	14	30	30
Slaughter cattle	25	14	14	25	25
Sheep	...	...	2	...	...

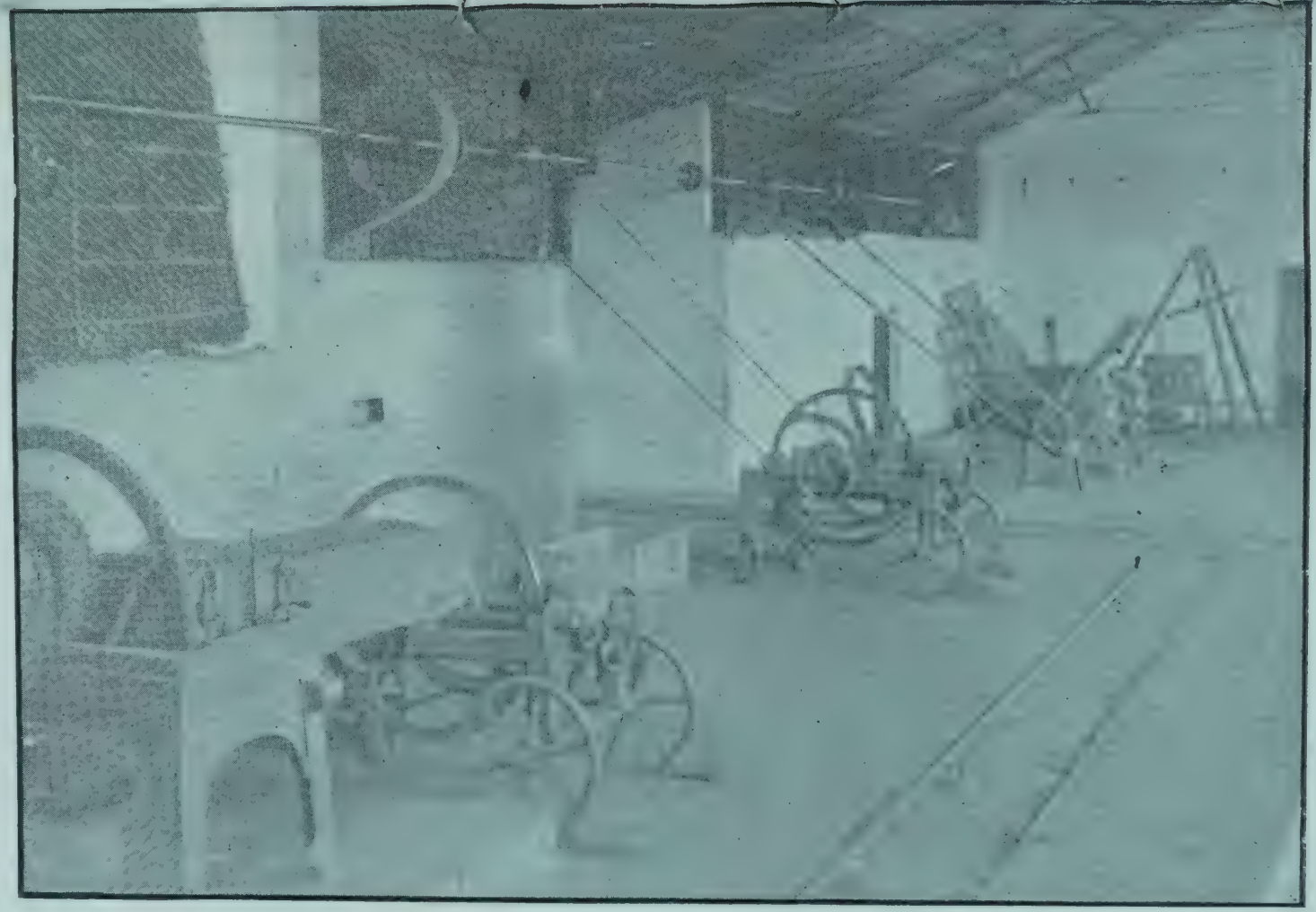


Photo-Electr. Survey of India Works, Calcutta 1903.

The chaffing shed, showing one of Richmond and Chandler's and two of Carson and Toone's portable chaff-cutters, a corn crusher, two oil cake crushers, and one pulping machine. All driven by the one shafting.

Feed and treatment of Government animals.

Practical experience has shown that the above scales are quite disproportionate, in some cases totally insufficient, while in others they are excessive. For instance, compare the scale of green grass with that of hay for horses of British corps. The scale of green grass in the dry season is 30 pounds and that of hay 20 pounds (both exclusive of bedding). Presuming for the sake of argument that the green grass at this season contained little moisture, still if dried and converted into hay, not more than 14 pounds of hay would be obtained. In the monsoon the scale of green grass (exclusive of bedding) is 36 pounds per horse. Now at this season of the year the grass naturally contains a large proportion of moisture, and the utmost quantity of hay that could be expected from it would be 12 pounds. It is therefore apparent that either the green grass ration is insufficient or the hay ration excessive. Obviously the ration should be 40 pounds of green grass in the monsoon months, 35 pounds from the end of the monsoon till 1st March, when the grass contains less moisture, and from the 1st March to commencement of the monsoon 30 pounds, as the grass is then almost dry owing to the intense heat. The hay ration, on the other hand, should be reduced to 16 pounds of good hay. The ration of English hay is 12 pounds, but it will be as well to make an allowance of 25 per cent. to make up for the difference in quality between English and Indian hay. When hay is issued to corps, a large proportion of it is carted away daily with the litter, whilst during the monsoon, when green grass is issued, the horses stand for the greater part of the day before empty troughs. The fact is that the sufficiency or otherwise of the Government scales has never been thoroughly tested, as under the system of supply by grass-cutters much more than the regulation quantity of fodder was expected from the grass-cutters, whereas hay was seldom or never supplied. There has been no better opportunity of testing this matter than at Allahabad, where for the last 18 years fodder, both green grass and hay, from cultivated lands has been supplied in full to some 2,500 Government animals, including the horses of mounted corps. Year after year the cry has been from the Officers Commanding corps during the monsoon and early winter that the green grass scale is insufficient. In fact, to prove this, experiments have occasionally been made by these officers in the conversion of a portion of their green grass ration into hay, with the result that the outturn was little over half the authorised hay ration. On the other hand, no complaint has ever been received regarding the quantity of the hay. This is perhaps one of the reasons why mounted corps finding the horses do not thrive on the green grass ration, frequently demand hay in lieu. It is estimated that at present fully five pounds of the hay ration is thrown out daily with the litter, or in other words, 22 maunds 32 seers per horse is wasted annually, or in a regiment of 640 horses, 15,800 maunds are annually thrown away. The value of this wasted hay represents a loss of some 15,000 rupees to Government. Surely it would be an economy to deduct this quantity of hay from the ration and expend a portion of the money so saved in a slightly increased ration of green grass as proposed above? In the case of the first class mule which is entitled to the same ration of green as a battery horse, *viz.*, 30 pounds, the hay ration is only 15 pounds as against the 20 pounds issued to the horse. The ration of hay and bhoosa is absurdly large, and during the Chitral Expedition mules doing very arduous work were found to consume only 10 pounds of hay or bhoosa daily, and the ration was reduced to this quantity without any falling off in condition. The scale for the second class mule calls for no further remark, being in the same proportion practically as that of the first class animal. In the case of the siege train bullock the disparity between the quantity of green grass and hay is even more apparent. The 25 pounds of hay allowed is about equivalent to 60 pounds of green grass, yet we find it is only entitled to 35 pounds, which in the rains especially is totally inadequate. It is also not apparent why in this solitary case the hay and bhoosa are not valued at the same ratio. The scale of ration for the Army Transport bullock is the same as that for the horse, but, as with his siege train brother, the hay ration is too great, while the green grass ration is inadequate.

Feed and treatment of Government animals.

The following is a fair scale for all animals:—

	Hay or bhoosa.	Green Grass.			Green Crops.		
		From 16th June to 15th September.	From 16th September to end of February.	From 1st March to 15th June.	Silage.	Kharif or monsoon crops.	Rabi or winter crops.
Horses of British and Native corps, yaboos and Battery mules.	16	40	36	32	...	36	32
Army Transport bullocks	14	35	32	28	28	32	28
Siege Train bullocks .	18	45	40	36	36	40	36
Slaughter cattle, first class, and mule or pony	12	30	27	24	24	27	24
Second class, and mule or pony and Cavalry pony	10	25	22	20	20	22	20

The above scale is exclusive of bedding, which is at present only allowed to horses, at the scale of 6 pounds of dry coarse grass or 10 pounds of green.

The following grasses should be used for bedding:—

Kansa, Kusa, Sărpăt (young), Ganrar, Bamani,

or other coarse grasses not readily eaten by horses.

Hay scale.

It will be observed that hay has been estimated at the same scale as *bhoosa*, but as the regulations at present stand, in the case of Siege Train and Army Transport bullocks, *bhoosa* is issued at a smaller scale than hay, though in the case of mules the identical quantities are allowed. *Bhoosa* should be issued at the same rate as hay, as its nutritive properties are not greater than those of hay, while the weight must necessarily be made of a proportion of dust caused by the process of threshing and treading out with bullocks. Well-made hay, on the other hand, contains no dust.

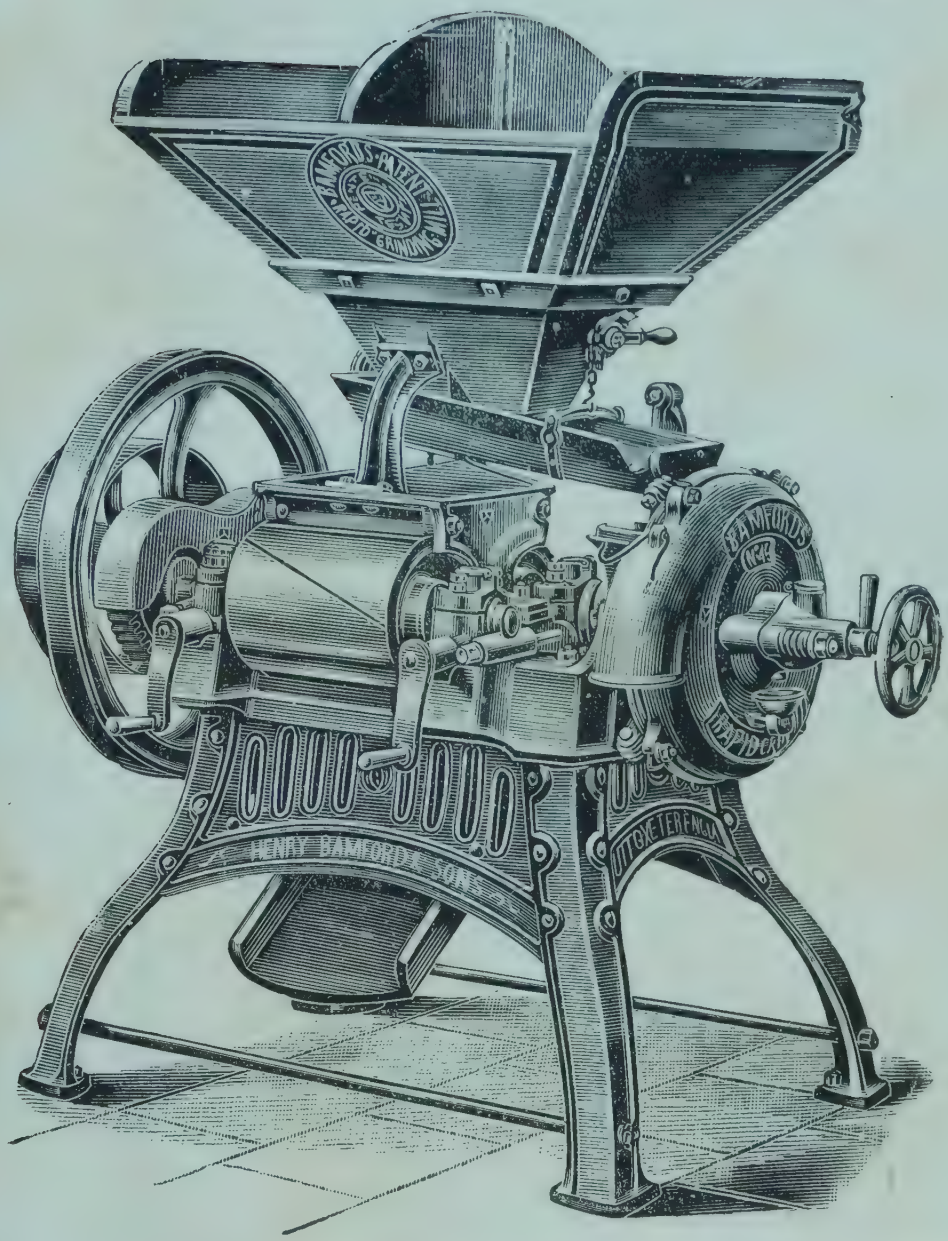
Silage scale.

The scale proposed for silage is a somewhat liberal one, provided that the silage is issued as is done at Allahabad, that is, thrown out from the pits and exposed for a few hours to the sun and air before being carted to the cattle lines. If cut with a hay knife and sent direct in blocks, for issue, the quantity would not be sufficient, as the blocks then contain over 25 per cent. of excess moisture. There should, therefore, be a rule framed regarding the method of issue. The method of cutting out blocks with a hay knife, though neat and systematic, and suited to a place where the issues are small, is quite unsuited to places where the number of animals fed is very high and a pit only lasts a few days. The scale then having been definitely fixed, the next point for consideration is how and when to place the fodder before the animals, so as to avoid wastage, while at the same time the animals will derive the utmost nutriment obtainable from the fodder.

Fodder how issued.

The fodder ration should be divided into four parts, and, provided the animals are not absent at work, in which case arrangements must be made to take fodder with them, a fourth quantity only should be placed before the animals at a time. The quantity fed at one time to an animal should on no account be more than it can consume, as otherwise the fodder is liable to be trampled under foot and become saturated with urine, when it will be refused, and it will be only fit for the dung pit. Careless attendants place half or more of the ration at one time in front of their animals to save trouble,

PLATE 32.



Bamford's "Rapid" Corn-crusher will either grind, bruise or flatten any description of grain as required.

Feed and treatment of Government animals.

Even should the animal be able to eat a larger quantity than this fourth share, it should not be given, as it will thus have nothing to eat for the greater part of the day. In fact the fodder should be fed to the animals in the same way as the grain ration. The largest portion should be given the last thing at night, while the smallest should be given immediately after the morning feed of grain.

Chaffing fodder.

It is very desirable, when possible, to chaff all fodder, as it prevents wastage and the food is preferred and more readily masticated in this state. It is also a good plan to mix a small proportion of fine chaffed hay with the grain ration, to ensure thorough mastication and to prevent animals bolting their grain, as some are inclined to do. It is even advantageous to chaff the green grass as well as green crops. This chaffing of fodder is one of the secrets of keeping animals in condition, a fact which is thoroughly recognised in England, Australia, and America, and if considered important there, how much more so in India where all fodder is of a coarser description?

Shelter for fodder.

Another important point is the provision of shelter for the fodder. The expenditure necessary for the purpose is not large, and is well repaid by the improvement of the fodder, the saving of waste and consequent improvement in condition of the animals. All that is necessary is protection from rainfall and excessive heat of the sun, and a suitable building for the purpose is an open shed with corrugated iron roof on railway sleepers or masonry supports. Nothing is so injurious to grass or other fodder as when wet by rain it is bundled or placed in heaps. This invariably results in fermentation, gives a bad smell to the fodder, which in consequence is frequently refused by the animals. Green grass especially should be kept spread out in the shed whether rain is falling or not, not so much with the object of drying it, but because it ferments quicker than any other fodder. The present practice in British mounted corps during the monsoon, there being no sheds authorized for shelter of fodder, is to keep the grass heaped up in the open for two days, and occasionally, when opportunity offers, spread it out to dry. This practice was pursued in accordance with an official circular directing the drying of all green fodder prior to issue, which order originated owing to the habit of the grass-cutters in former days dipping their bundles of grass into water to give them a fresh appearance and to increase the weight. The grass was also often cut off swampy lands. This fodder caused colic. Owing to the want of space for spreading and shelter from inclement weather, the order resulted in a worse state of affairs owing to the above-explained causes, in addition to which the animals also lost in actual bulk of rations, for, owing to dryage, it more resembled hay, while its weight was far less than that of the authorized hay ration. What was practically intended by the order was that hay only should be issued during the monsoon. This is a delusion, which is proved, as the horses of private individuals and those of the Native Cavalry are always fed on green grass and thrive, if not better, at least as well as those of the British corps. In some stations the horses of all corps are fed entirely on green grass in the rains with good results.

Security against contagious diseases.

Before the institution of Government grass farms, and still in many places where farms do not exist, it is the custom of grass-cutters to bring in grass cut or *chiloed* from swampy land or inferior pasture lands at the time being grazed by village cattle, which may not unlikely be suffering from contagious diseases. The ill effects of this practice are too apparent and too well understood by most old Indian officers to need comment. Indeed, the question of the best method of preventing disease and the havoc caused thereby among Government animals perplexed the Government of India for many years as, under the system in vogue, the horses of mounted corps were seldom or ever free from contagious disease.

Cultivation of grass and its good effects.

The cultivation of grass now as a crop on scientific principles and the strict conservation of farm lands has solved this difficulty. Take the case of many stations where anthrax and other epizootic diseases were very prevalent. Since the inauguration of grass farms in 1882, anthrax and glanders have considerably decreased and the deaths due to climatic causes have been very few. The same remark applies to all the Government animals in the station. This immunity from disease is no doubt partly attributable to the farm having taken up the whole of cantonments and the consequent exclusion of outside cattle from the neighbourhood of the animals' lines and sphere of daily work and the production of uncontaminated foods.

Feed and treatment of Government animals.

Best system of feeding green fodder throughout the year.

Green fodder should be cut and issued in the evening of the same day to corps for consumption the following day. It is weighed over by a representative of the farm to a representative of the corps, who grants a receipt to the former for the quantity received. As the weighment of a whole regiment's requirements is a tedious and lengthy matter, it is usually taken over by computation, which is quite as accurate as ordinary weighment, in the following manner:—The grass cut is tied by the grass-cutters into bundles approximating one maund each, and which from constant practice the men guage very accurately. Ten per cent. of these bundles, selected half by the issuing and half by the receiving party, are weighed, and the whole taken over at the average weight arrived at. The grass should then be delivered at the lines, if not actually made over at the stables, and, in order to prevent fermentation, at once spread out as thinly as space will allow, not exceeding 4 inches in thickness. The following day this fodder is fed to the horses, and should be turned over several times until consumed. There is no necessity to attempt to dry the grass, for good hay cannot at this season be made, and the animals prefer the grass in its green state. Practical experience proves that this system of feeding on green grass will not produce colic, especially in the case of grass farms where the grass is grown on cultivated and preserved lands. Young grass will, no doubt, when first issued in large quantities, cause a certain amount of purging for a few days until the horses have become accustomed to it. After a long spell of dry and heating fodder during the hot weather, this purging is really of benefit to the animals. Green grass is, however, not issued until ten or fifteen days after the break of the monsoon when the grass is about 18 inches high on manured land. At this stage, the grass is fairly mature, and frequently some grasses flower within three weeks of the commencement of the rainy season. It must be remembered that young grass produced as in this country from old existing roots, is a very different product from young grass grown from seed; hence it has more substance than the latter and is less liable to scour animals fed on it.

Experience shows that in a hot country like India animals thrive on green fodder during the hot months of the summer and monsoon, while in cold weather a little hay, which is more heating than the green fodder, may be substituted with advantage for a portion of the ration.

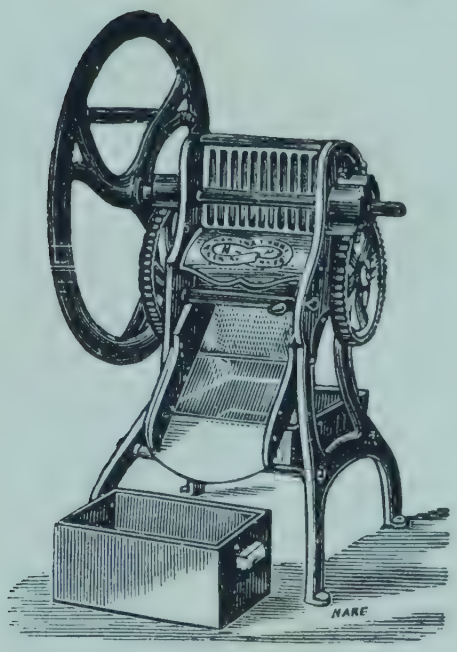
Mixed herbage.

Many people have a fancy for feeding on only one species of grass, usually *dub*. This is a mistake, as the best results are obtained by feeding on a mixture of good grass known in the vernacular as *pachmel*. The natives of India are well aware of this fact, and so are the Native Cavalry. The reason of this is, that the horses, like human beings, require a variety of food, and besides at certain seasons some grasses, such as *dub* in the monsoon, are bitter while others are sweet, and, in fact, they counteract each other. Like all cereals various grasses draw various kinds of nutriment from the soil: some more or less of one substance than the other. So by feeding on one particular grass the benefits derived from mixed herbage are lost.

Issue of hay.

The usual practice as regards the issue of hay is to hand over stacks in bulk to corps, the contents being calculated by measurement. This is a very unsatisfactory arrangement both for the farm and for the receiving corps. It frequently happens that in such cases the hay when brought into issue has been considered far short of the estimated quantity. This is probably due to the syces of the mounted corps taking the grass surreptitiously either for the battery horses or for their own use, or it may be due to careless and liberal weighment when issuing and to loss sustained owing to rain or excessive evaporation after the stack has been opened. Whatever the cause, the shortage when found is invariably attributed by the corps, which has no other means of accounting for it, to inaccurate calculation of the contents of the stack at the time of taking over. This difficulty is not even overcome when the hay at the time of being stacked is weighed by the corps, as when from any of the above-mentioned causes the fodder runs short of the estimate, the regimental authorities have to fall back on the plea of excessive dryage. The only arguments in favour of this system of issuing hay is the supposed economy to the farm in labour. This argument is fallacious, as labour must in any case be expended in weighing the grass either before or after stacking. Even were labour saved, the economy would be doubtful, as probably more expense would be incurred in making up deficiencies of hay than could possibly be saved in labour. It should be borne in mind that it is a difficult matter to determine

PLATE 33.



Oil-cake Crusher by Carson & Toone.

Feed and treatment of Government animals.

what dryage is to be expected, as it depends on the stage of maturity at which the grass was cut for hay, for the younger the grass, the greater the dryage in the hay. It also depends partly on the quality of the grass, that is, whether it is grown on manured land or on ordinary dry unmanured land. The former being more succulent will naturally contain more moisture, and will therefore sustain more loss from dryage. Hay is seldom issued to the Transport animals or milch cattle. The order which authorized hay to be handed over in bulk has since been rescinded, and all hay is now weighed and delivered daily to mounted corps by farms. The best system is undoubtedly that which is preferred by corps themselves, namely, to stack the hay and issue daily from the stack to corps which have their own carriage, and in the lines to those which have none. All issues should be carefully and accurately weighed by spring balances, or better still by platform scales. Bedding, however, may be issued either daily or weekly, as suits the convenience of officers commanding mounted corps.

Issue of green crops.

Green barley, wheat, *sorghum*, and oats cut before the grain ripens make excellent fodder for horses. They should be fed at the same scale as green grass, and cattle thrive well on this fodder even in winter. Care should be taken that it is not allowed to ferment before being fed. It is an excellent plan to chaff it together with a small proportion of hay. Vetches, peas and other pulses, however, should not be fed to horses for fear of colic. The above green crops, together with any others, may be fed to bullocks, mules, or milch-cattle, freshly cut, and of course chaffed if possible. When the fodder is harvested with the grain in the ear (almost ripe), the grain ration may be stopped, or at all events reduced in quantity.

Issue of silage.

Horses, as a rule, do not care very much for silage, but they have been fed on it with good results. It is, however, an excellent remedy for skin diseases in horses such as prurigo. Horses cast from the artillery as suffering from incurable skin disease have been known to become completely cured after a few months when fed *entirely* on silage. Mules thrive on it, and it is excellent for horned cattle. It is best fed mixed with a proportion of other fodder. Bullocks and cows prefer silage to any food, and will greedily eat it even the first time it is placed before them.

Seasons at which the various descriptions of fodder should be issued.

Green grass throughout the year whenever possible. Green crops from August to November (*kharif* crop), and from January to April (*rabi* crop). Hay in the cold season mixed with other fodder and also in the hot weather, to horses, as they cannot eat silage. Silage in the hot weather, when other green fodder is not procurable.

Differences in the physical condition of horses and bullocks.

There is a great difference between a horse and a bullock. The former requires a small quantity of fodder of good quality, while the bullock requires bulk to fill his belly. If the bullock does not get a large quantity he will not thrive, however good the fodder may be. The most economical method of feeding a bullock is that practised by the natives of India; that is, he should get a comparatively small quantity of nutritious fodder for the sustenance of his bulky body, and the remainder of inferior fodder, such as weeds, old straw, damaged *kirbi*, chaffed and mixed with oil-cake or other palatable matter. This is for bulk. Bullocks working hard and fed by this method will always keep in prime condition. If the Indian farmer fed his working bullocks entirely on superior fodder, he would not be able to pay his way, nor could he utilize his coarse fodder or refuse, such as weeds and other unmarketable straw and fodder. If this system were adopted, as far as possible, in regard to all Government animals, a very large saving would result. How frequently it happens that fodder for Government bullocks is rejected on account of its coarseness. As explained above, the ration of the bullock is frequently short in quantity, but very rarely can it be too coarse in quality, provided, of course, that it is chaffed, as it should invariably be. On one occasion 15,000 maunds of *ganrar* grass, grown on railway embankments, were condemned on account of coarseness; but when chaffed and re-tendered every blade was eaten by the cattle, and the officer who had rejected it was anxious to procure more, and was much surprised to learn this was the identical fodder he had previously condemned! The fact is that condemnations of fodder are chiefly due to a want of knowledge of Indian grasses. This remark, however, does not apply so much to the Native Cavalry, where the Commanding Officer has the benefit of the advice of the Native Officers, many of whom are good judges of Indian fodder. British corps have almost invariably a strong preference for

Condemnation of fodder.

uncultivated *dub*, which is short and chiefly roots. In some cases they actually object to cultivated *dub* on the ground of coarseness, and it is difficult to persuade them that the cultivated species is *dub* at all. Similarly, some of the best monsoon grasses are objected to on account of the broadness of the leaf, while it is a fact that the best monsoon grasses all have broad leaves. Mistakes of this nature would seldom occur if the animals themselves were referred to. If the animals eat it readily, it is at all events some indication that the fodder is not inferior. The grasses which are not fit for fodder are very much in the minority. The one which should chiefly be avoided is the above referred to short-rooted *dub*, for this grass cannot be entirely freed from dirt, and its short growth points to the probability of its having been taken off land previously grazed by village cattle. The risk entailed of importing disease in this manner cannot be over-estimated. Should it, however, become necessary to feed animals off outside land, the grass should be carefully examined for a black fungus growth on the stems, and if found it should be rejected.

Care should also be taken not to feed grass affected by 'smut' in large quantities to animals, especially horses, as it affects the kidneys. Smut is a disease that attacks the flower, turning it into black dust. It is found in crops when heavy rain falls at the time when the grain is forming or on account of dew. A small quantity of smut, however, is of no consequence.

Mules

Mules being hardy animals will thrive on almost any description of fodder as long as they get sufficient of it. In the eastern districts they thrive well on bamboo leaves, and during the Chitral campaign the mules on the Lowarai pass worked satisfactorily for some time on a fodder ration of wild indigo.

Bullocks and milch cattle.

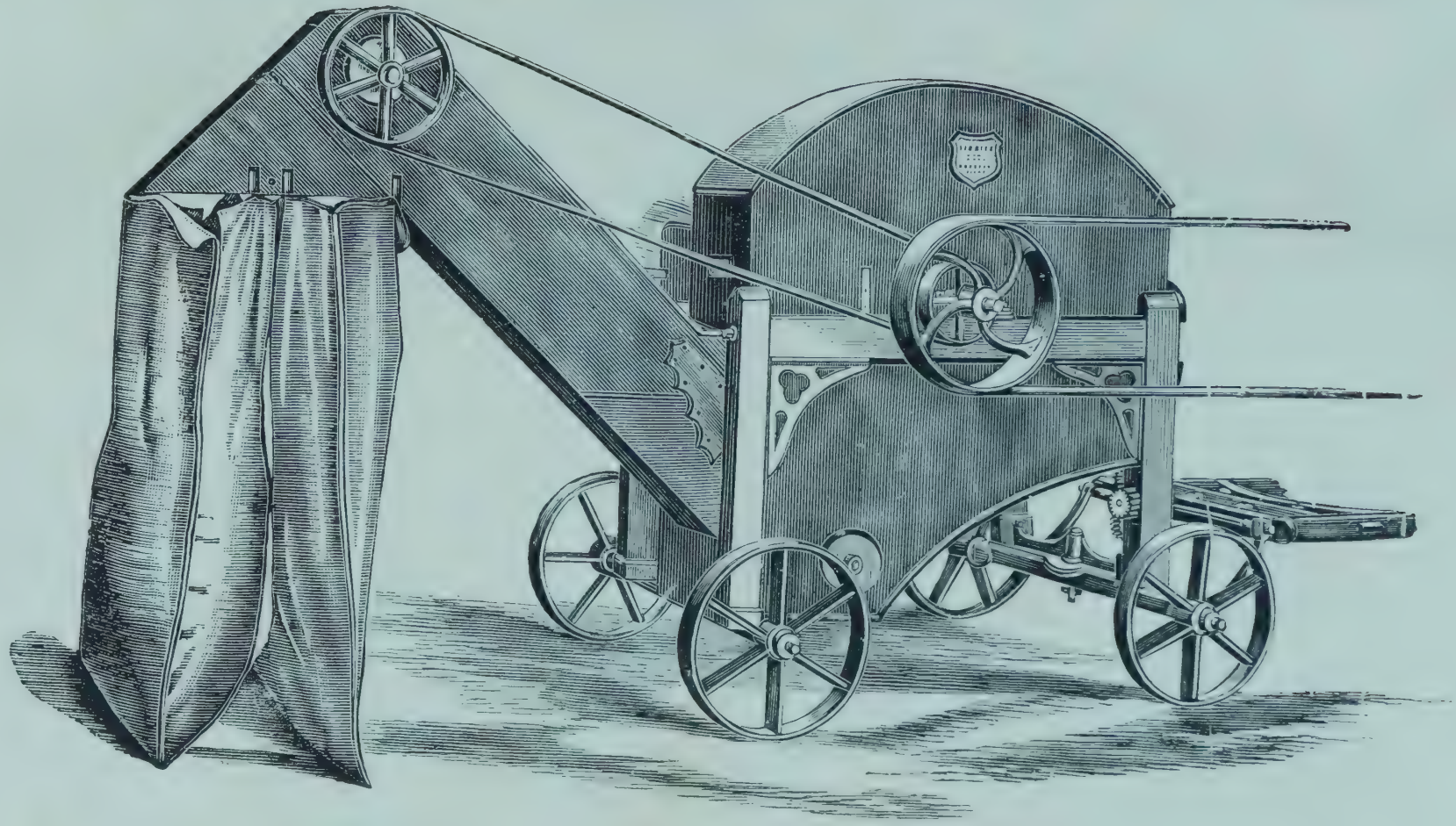
Bullocks and milch cattle are somewhat fastidious animals, and there are certain grasses which horses like and bullocks do not much care for, *dub* for instance. Regarding the suitability as fodder of the different varieties of grasses for the various classes of animals, chapter XVIII may be referred to. It should be especially remembered that coarseness as shown by thick stems is not a sign of poor fodder; rather, on the other hand, it is an indication that the grass has been grown on rich soil, and is therefore more succulent than the finer stem grass grown on unmanured land. It is true that coarseness is a defect in that the fodder is difficult to masticate, but this can be remedied by chaffing. Take the case of *karbi*, which is often an inch thick: unchaffed it is scarcely edible, but when chaffed it makes an excellent fodder.

Former system of fodder supply.

Prior to the inception of grass farms the Government horses were fed by the grass-cutters system. These men went out into the district and practically robbed the grass from the lands of the ryots. In many cases they had to go long distances from cantonments. The grass was in most cases obtained principally off uncultured land, and consequently contained very little nutriment. In some cantonments, Allahabad for example, Government carriage had to be supplied to the British corps to assist their grass-cutters in bringing in the fodder, as grass was not obtainable within 20 miles, and the men had to bring in two days' requirements every second day. In the case of Native Cavalry the transport ponies were worked to skin and bone, and were in consequence often unfit for field service. As the ponies were scarcely ever in the lines, no supervision could be exercised over their feeding. In addition to this, there were conflicts with the ryots and the civil authorities were troubled with frequent assault cases, and in very rainy weather the horses sometimes got no grass at all, while often only a scanty supply of short grass, dug up with *khŭrpas* from swamps, was obtainable.

Sir Herbert Macpherson solved the difficult problem.

The question of supply of fodder for mounted corps became a yearly increasing difficulty. This was no doubt partly due to the increasing trade in export of grain and the consequent cultivation of waste lands. At length the difficulty became so great that it was contemplated removing the Native Cavalry from certain stations, such as Cawnpore, Allahabad, and a few other stations, and eventually the late Sir Herbert Macpherson put forward a proposal which solved the question. This proposal was that land should be taken up by the cantonment authorities, both within cantonments and at some distance away. The former for the cultivation of grass as a crop, and the latter simply for the preservation of grass. The experiment was first tried in 1882 at Allahabad, where the greatest difficulty in the supply of fodder was being felt, and the



Carson & Toone's Portable Chaff-cutter. Wooden frame-work.

following year at Cawnpore. All difficulties in connection with the fodder supply soon disappeared, while the civil department was relieved of a deal of worry and extra work, and at the same time the unfortunate ryot was able to feed his own cattle on his grass lands and his crops were unmolested. The Government animals obtained good and excellent fodder, and ran no unnecessary risk of contracting contagious diseases. The transport of native mounted corps regained their efficiency, the daily requirement being merely carried short distances. The health and general appearance of cantonments were vastly improved by the conversion of land once cultivated with high standing crops into rich meadow land; while the farms actually became a source of considerable revenue to Government.

Grazing.

In India grazing is of great benefit to all animals, including horses, but unless it is carried out systematically it is not economical to the landowner, and of little benefit to the animals themselves. Except in forest areas and in Native States, but very little grazing land now exists for the cultivators' cattle, owing to its having been brought under cultivation. This seems a very serious matter, as good pasture, no doubt, helps the ryot to keep his cattle economically and in good condition. Grazing should not be allowed until the grass begins to flower, say a month or six weeks after the commencement of the monsoon. If grazed earlier, the grasses are too young (for it must be remembered that on uncultivated lands the grass is much more backward than that grown on cultivated land) and will not contain much nourishment, and for each blade consumed by the animals at least four will be trodden under foot into the wet soil. At the same time the future growth is retarded, and little more can be expected the same season from the land. If, on the other hand, the grazing is left till the grass is ripe, the animals will merely nibble off the heads of the grass, and the stems will be left to be trampled under feet and destroyed. It is a common thing in Indian cantonments and on Government lands in general, to see cattle turned on to graze as soon as the rainy season commences, when the grass is only a few inches high. The land then very soon becomes perfectly bare.* This is especially the case when too many cattle in proportion to the area of grazing land are turned on. The natives well know the harm resulting from this practice, but the grazing being sold by auction, the lessee is naturally concerned with his profits and not with the interests of the cattle owners to whom he sublets the right of grazing.

The best system of grazing.

The most economical method of grazing land, so that the full benefit may be derived by the cattle and their owners, is to divide the land into plots and graze only one plot at a time. At least five plots are necessary for each herd of cattle. Each plot should be sufficiently large to provide ample grazing for the whole of the cattle for at least one week. The cattle are then turned on to the next plot, and so on till all the plots have been grazed. By the time the last plot has been grazed, the first will have had a month's rest and the grass will then be in prime condition for grazing a second time. When fit for the plough it is often advisable to give each plot one cross ploughing immediately after the cattle have finished grazing it. This ploughing opens up the soil which has been trampled considerably under foot by the cattle, while at the same time it allows the rain water to percolate, and mixes the cow droppings, both solid and liquid, with the soil. The plank, a *pahata*, should not be run over the land after ploughing in this case. The animals should not be kept more than a week on the same plot, nor indeed after the grazing has become scanty, as damage will be done both to the grass above the surface and to the land. If animals are kept for long periods on the same plot, the grass becomes fouled with droppings and it is not readily eaten, unless heavy showers of rainfall wash away the offensive matter. Sheep should not be grazed on the same lands as cattle, for the sheep prefer the short grass, being close grazers, while the former prefer it somewhat long. No grazing whatever should be allowed immediately after heavy rain, as nothing is more detrimental to grazing land than being trampled when saturated with water. One day's rest will probably dry up the excessive moisture or allow it to drain off.

Causes which ruin pasture land.

Constant and excessive grazing, without allowing intervals for the land to recover itself, will ruin the finest pasture land. If this is the case in Europe, how much greater must the loss be in India, where in the hot summer months many of the

* An ideal grazing ground has a thick bottom growth.

grasses die for want of irrigation or moisture, even when not grazed and trampled under foot. It should also be borne in mind that in India the land does not benefit by cowdung droppings, as the natives will steal this for fuel even under the strictest supervision, while if not removed by the natives the dung and the urine are to a large extent washed away into nullahs by the very heavy rain which falls during the grazing season. The grazing season proper lasts from the commencement of the monsoon till the latter end of November, some five months in all. After November the grazing is scanty, but if necessary it may be continued without much harm till the end of February. From the beginning of March till the monsoon the land should be left fallow and no grazing allowed. When land has been ruined by constant grazing, the best method of restoration is to discontinue grazing and to allow the grass to seed itself for one year. It may then be grazed and the seeds trampled into the soil by the hoofs of the cattle. In fact the land should be preserved from the commencement of March till about the end of October. This over-ripe grass will not give very good grazing, it is true, but the following year the grazing will have increased fifty per cent. It will often pay well to lightly top dress pasture land, especially if it is required for the grazing of milch cattle.

Meadow land not grazed.

Meadow land off which fodder is harvested should not be grazed except perhaps the aftermath, that is, the growth that comes up after the hay crop has been harvested. It should then be only permitted where the crop has been cut by the mowing machine in order to graze the thick stems of the grass left behind. When the aftermath is grazed, the cattle should not remain on the land more than one month on end. Some of the best manured grass lands have been ruined in the early days of grass farming by permitting them to be grazed. The secret of grass cultivation is to keep the top surface of the soil soft, and this cannot be done if it is trodden by cattle at graze and more especially when the soil is clayey.

Grazing for Government Transport animals.

In most cantonments it is usual to set apart certain lands for the grazing of siege train and other Government bullocks. This was no doubt a necessary measure in the old days when the animals being continuously fed on dry fodder the grazing came as a wholesome change, but at the present time, when the animals are chiefly fed by the grass farms on green fodder, very little grazing is really necessary, except, perhaps, as a means of eking out the present scanty green grass ration. Grass farms have to provide grazing lands for this purpose free of charge. Slaughter cattle do require grazing if only for the sake of exercise, but it is very necessary that they should be grazed quite separately from either outside or Government animals. If grazed with outside cattle, there is constant danger of importing any epizootic diseases which may be prevalent in the district, while at the same time as from one hundred to five hundred cattle are purchased monthly for slaughter (according to the number of British troops to be fed) from the surrounding country, it follows that there is great danger of disease making its appearance among these animals after purchase.

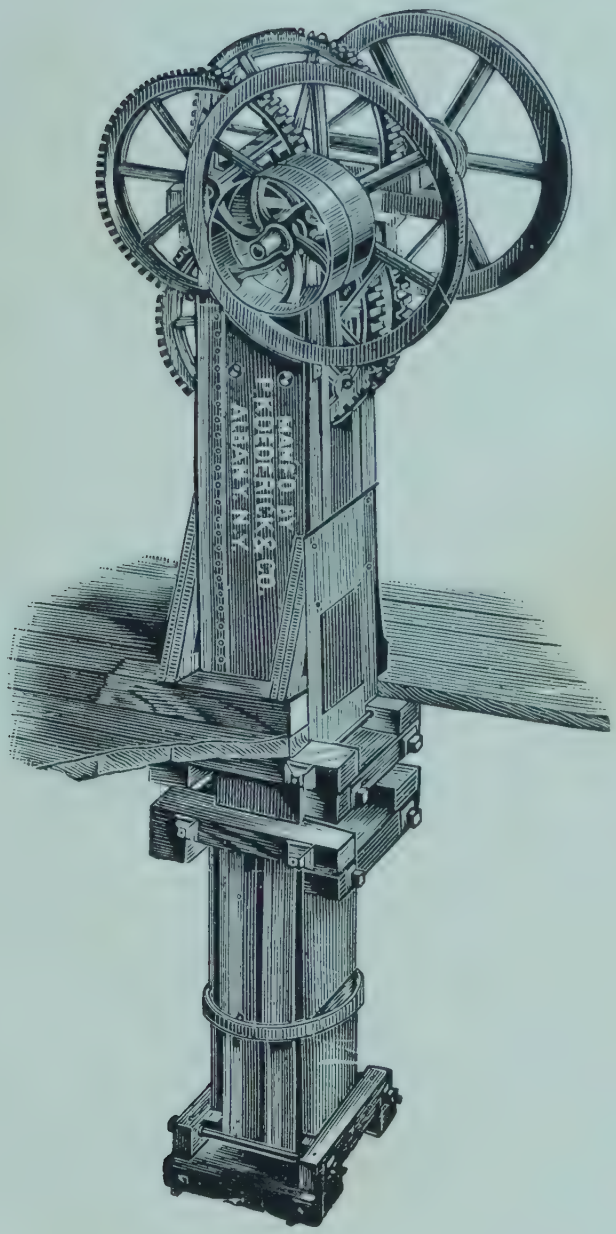
Grazing for dairy herd.

Where dairy farms exist, every endeavour should be made to keep the dairy cattle entirely separate from the slaughter animals or other outside cattle. This will be found in practice a somewhat difficult matter, but the best plan is to have the dairy cattle housed and grazed at least a mile from the slaughter animals. These precautions are imperative, as any neglect would very probably result in the extermination of the whole herd by rinderpest or other contagious and fatal diseases. When grazing grounds are provided for any class of Government animals, the land set apart for the purpose should be as close as possible to the animals' lines to avoid unnecessary damage caused to cultivated grass lands by the cattle going to and from their grazing ground as also for convenience's sake.

Public grazing.

If, in exceptional cases, it is deemed advisable on economical grounds to lease out outlying land for grazing of cattle other than Government animals, the best plan is not to let out the whole land by public tender or otherwise to any middleman, but to lease grazing rights to the owners of cattle direct at so much per head of cattle or sheep. (Goats should never be allowed to graze in any cantonment on account of the damage they cause to trees and shrubs.) Notice is given by beat of drum that on a fixed date grazing will be allowed, and when the owners are collected on the date notified, the rates are made known to them.

PLATE 35.



Dederick's Perpetual Press.

Feed and treatment of Government animals.

The usual rates for the season, say from 1st August to 30th April, are—

		Rs.	a.
For each	buffalo	4	0
„ „	osar (young buffalo not yet calved)	2	0
„ „	male buffalo	2	0
„ „	buffalo-calf	1	0
„ „	cow	3	0
„ „	heifer	1	8
„ „	calf	0	12
„ „	bullock	2	0
„ „	young bull	1	8
„ „	pony	2	0
„ „	donkey	1	4
„ „	sheep	0	4
„ „	hundred guinea fowls	5	0

A vernacular certificate signed by the officer in charge of the farm is given to each owner, showing the number of animals of each description he has a right to graze and the amount paid for such right. The counterfoil which gives the above details is signed by the owner and remains with the farm officer. Cash payments should be insisted on in advance. As natives invariably attempt to graze more animals than they have purchased the right for, and indeed many graze animals without having acquired any right at all, it is usual to occasionally and unexpectedly check the number of cattle at graze. This is done by collecting all the animals into one spot, and each owner is made to produce his parchment and drive off his cattle. Any extra cattle found or animals unowned should be rigorously impounded. This method is well understood by the natives. The inadvisability of permitting outside or village cattle to graze at all within cantonment limits cannot be too forcibly impressed. It is scarcely worth while for the sake of the small income derived from the grazing to incur the risk, which is a very real and serious one, of importing diseases among the valuable Government animals, such as Artillery and Cavalry horses, dairy cattle, Transport animals, etc. There is no Government ruling which compels the cantonment authorities to provide grazing for village animals, and it should be provided by the civil department on district lands.

Housing of farm animals.

Every working animal in this country requires shelter of some kind, during the winter especially. The natives have a saying to the effect that warmth in cold weather is as good as a feed. In the hot weather animals do better under trees in the day and in the open at night, but in the rains shelter is advisable, while in the cold weather shelter from winter rains is almost a necessity, unless good warm jhools or blankets are provided. It will be found cheaper in the end to erect shelter than to provide jhools, which usually last for only a year.

Where farms can manufacture their own bricks, shelter can be provided at very little cost. The cheapest description of shed is of course one with walls made of mud or kacha bricks, with a roofing of common sundried tiles, supported by *ballies* (beams) and bamboo frames. Though cheap, this kind of shed is not economical in the long run, as it needs constant repairs, and after about ten years requires entire renewal, as the *ballies* and bamboos are soon destroyed by white ants and other insects, while the *kacha* wall is gradually washed away by successive rains. The original cost of such a shed for 100 cattle would be from Rs. 300 to Rs. 400.

A good substantial shelter can be made of *pukka* bricks fixed with puddled clay instead of mortar, trusses and purlins of seasoned wood in lieu of ballies and bamboo frames, while the roofing should be composed of Goodwyn tiles. The cost of such a shed for 100 cattle would amount to about double that of the former.

It is best to have the floors of brick stood on end *fixed in mortar* and, pointed with cement, slightly sloped, so as to prevent the urine soaking into the soil and making the stalls foul and unhealthy, and also with a view to saving the urine, which is a valuable manure. The usual slope is about 1 in 40. These floors can be washed and thoroughly disinfected when necessary. The troughs should be constructed so as to allow

for two troughs with a space between them of 2 feet. The troughs themselves may conveniently be 2 feet high and 1 foot 6 inches broad. The object of the space between the troughs is to allow of a trolly or hand-barrow passing between the troughs to save labour in feeding. The animals face towards the troughs and each other, and are picketed to iron rings fixed in the masonry of the troughs. This does away with the necessity of pegs, which are dangerous. About 7 feet in rear of each trough is a drain to carry off the droppings. This small drain need only be about 1 foot wide and 6 inches deep, and must of course be on a slight slope. The whole of the flushings, including the urine, should thus be conveyed direct to the fields at some little distance and should not be deposited too far from or too close to the sheds. Where ground is available, the best distance between huts and sheds is from 50 to 150 yards.

CHAPTER XXI.

Farm Draught Cattle.

Care and treatment of live stock.

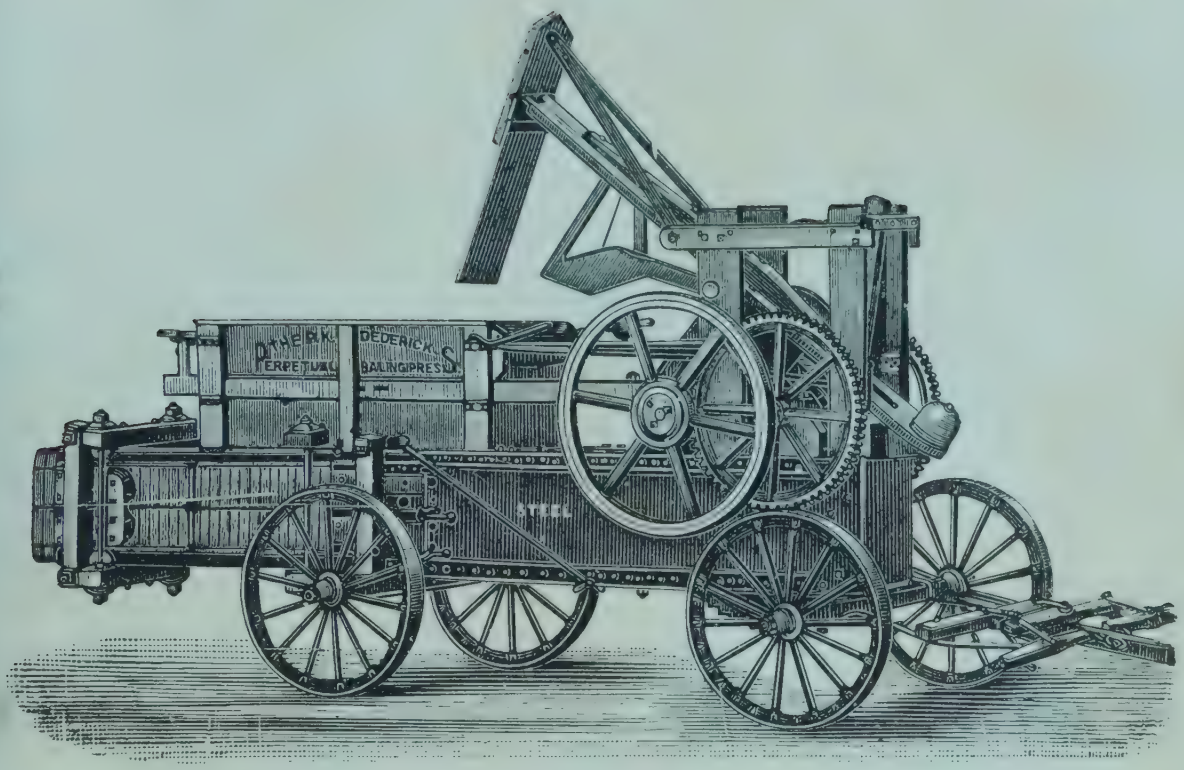
The best animal for farm work in general in this country is undoubtedly the bullock. Mules and horses, it is true, can be worked both in carts and ploughs, but their initial cost is more, the keep higher, the harness and gear required is more expensive, and they do not stand the heat as well as the bullock. The only advantage which horses and mules possess over the bullock for farm work is their quicker pace. Of course when large numbers of mobilization mules are kept, they should be utilized and kept in fairly hard condition on the farm, in carting, ploughing, drawing rakes, or any other work, but they should not be purchased for farm work, except as mounts for supervising staff. Bullocks, it is true, are slow, but they are hardy and can be fed economically, and the gear is a very minor item.

Best stamp of bullock for farm work.

The best stamp of bullock for farm work in general is not a very expensive animal, the price ranging in most districts from Rs. 80 to Rs. 150 per pair. They should be medium-sized animals, somewhat larger and heavier than the animals used by the ryots in the neighbourhood. The Hissar-bred bullocks are usually too tall, leggy, slow and clumsy for farm work, while they are constitutionally weaker than the better class of country bullocks. Some of the Hissar breeds are fairly good draught animals, but the majority are crosses of a large kind of animal suitable for siege train purposes. Most of the bullocks which have a strong strain of Carnatic blood in them make good farm animals. They are plucky, active and quick walkers, and are specially valuable for ploughing. Another excellent breed for farm work is that usually known as the Purbiah, Janakpuri or Tirhoot, which are procurable in large numbers at the Sonepur, Sitamarhi and Bhairoostan Fairs, and also in the neighbourhood of Janakpur, from which place they derive their name. These animals have proved themselves superior to most other breeds in the following points:—They are more compact, heavier, big boned and more powerful for their size. They are hardier, thrive better, are sounder and work to a later age. The sires and dams are so insignificant that it is scarcely credible that their stock should be so good. The secret, no doubt, is that the young stock are well fed and cared for from their birth upwards. Calves at the various fairs in Tirhoot are universally in plump condition, contrasting strongly with similar stock in most other districts of India, which are usually brought up in light condition. Loss of milk flesh undoubtedly results in animals maturing late, with weak constitutions, and they are quite broken down at the age of 15. Very good animals of this breed have been purchased in the past, but it is believed the breed is now fast dying out. For mowing machines a specially powerful stamp of bullock of quick pace is required, and for this purpose Hissar-bred animals with a Carnatic cross are most suitable.

Farm saddle and carts.

In cases where farms supply both British and Native Mounted corps, and the ponies of the latter are available for work, very few carts are required, for with the admirable arrangement of the *Sondka* saddle with a large net, very different to the commissariat pattern forage net, each pony carries from $2\frac{1}{2}$ to 3 maunds of fodder. If ponies are purchased for grass-farming operations, this saddle could easily be used with advantage. Pony mares should be purchased, as besides being used on farm work, they could all be covered by donkeys and mule-breeding could be combined in a most economical manner. They are very quickly loaded and unloaded, and this work



STEEL CASE BELT PRESS.

Dederick's Perpetual Press.

Farm draught cattle.

is done by the Cavalry grass-cutters themselves, thus saving considerable expenditure in labour for loading and unloading. The best and most economical cart for farm work is the ordinary country cart with a framework projecting over the wheels attached to it. If mobilization or other Army Transport carts are available for use, they can be usefully employed with a frame work, as can also Arsenal condemned carts of either the Maltese or other pattern, and it would then of course be unnecessary and inadvisable to purchase carts.

Ploughmen.

In the United Provinces and Bengal the best ploughmen are naturally those of agricultural classes, such as *Kurmis*, *Ahirs*, *Gujars*, and *Kachis*, while in the Punjab *Jats* and *Mehtars*. These men understand how to drive carts as well as plough, and know how to look after their animals. They also have a knowledge of the various crops, their *nakhats* (seasons for sowing) and of soils. Mussalmans and Brahmins should never be employed as ploughmen, as they are above the work, do not care for animals, and are apt to intrigue. It is always advisable to employ some *chamar* ploughmen or cartmen, as they can easily be induced to do any dirty work, which the higher caste natives would object to owing to caste prejudices.

Ages at which cattle should be worked.

Bullocks should commence to do light work, such as ploughing, shortly after castration, when they usually have four full-grown permanent teeth and are about three and a half or four years old. As soon as six teeth are well up they may be put to regular work. Young draught stock must be carefully treated and lightly worked, as bullocks worked too young break down prematurely, and are particularly liable to deformities of the fore legs such as splay-foot and knock-knees. The very best bullocks are spoiled by bad drivers or ploughmen who use their hands in driving instead of their whips. A driver should not touch a bullock at all with his hands except when grooming, and certainly should never twist its tail. Cattle properly driven and cared for and kept in hard condition, without overwork, will work well up to 18 years of age, and in exceptional cases up to 20 years.

Best method of feeding bullock (grain).

The best and cheapest food for bullocks during the cold weather and monsoon is cotton-seed in districts where cotton is grown. Cotton-seed contains more nitrogen than gram or any other Indian grains, and is therefore eminently suited for bullocks in hard work, except perhaps in the hot weather. If given alone, it is, however, not very palatable, and it is therefore best to give it mixed with half its weight of linseed or mustard-cake. With mustard-cake, which is usually cheaper than cotton-seed, it may be fed in equal quantities. Oil-cake should be soaked in water for three hours before being fed to the animals. The cotton-seed should then be mixed with it and four pounds of chaffed hay or green fodder of any kind added together with the salt ration, and the whole fed as a mixture. Where cotton-seed is not available, but *moth* or *kulthi* is procurable, these may be substituted. Gram is usually more expensive, but it is very nutritious. The driver and his family, too, are particularly fond of gram, and will loudly protest against the introduction of cotton-seed, oil-cake, etc., which are not edible by human beings. The native of the country very rarely gives any gram to his bullocks, and never to milch cattle, yet almost every European owner of milch cattle feeds on grain on the advice of the gowálla.

The Supply and Transport Corps have adopted this method of feeding Government bullocks with very great advantage.

Brewery and distillery refuse.

Brewery grains are also a valuable food for bullocks and can be obtained cheaply where breweries exist. Even the *mohwa* after distillation is a good food for cattle. It is, however, undesirable to feed cattle entirely on such grains, as once they are accustomed to them the animals fall off in condition when the issue is stopped, and not more than half the ration should therefore consist of brewery or distillery refuse.

Babúl pods or *Gingaris*.

The pods of the *babúl* or *kikar* tree are very fattening and nutritious for bullocks, cows, mules, sheep and goats, etc. These pods should be knocked off the trees just before maturity, and collected and stored ; or they may be allowed to ripen on the trees and fall naturally (towards the end of April) when the animals could graze the ground. The latter is perhaps the better course when the land is strictly preserved and there is no risk of the pods being robbed.

Salt.

Salt is a necessity for all farm animals. The Government scale is 2 drams or ⅛ oz. daily and a pound per month for each bullock for licking purposes, but dairy cattle require for all purposes about double this scale. Besides giving salt in the food and hanging it up for the cattle to lick at pleasure, the natives use about ¾ lb. monthly for rubbing the tongue and the inside of the mouth of each animal once a fortnight, as they consider this prevents the disease known as *mirki*.

Feeding and watering.

Bullocks and other farm animals should be fed and watered at regular hours, if possible three times a day, though this cannot be adhered to with working bullocks. They should be watered before being fed, and not after, or they are liable to colic.

CHAPTER XXII.

Diseases of Horned Cattle and their Treatment.

Treatment of sick cattle.

During the past 13 years at Allahabad, there have been many opportunities for the examination and treatment of all the diseases to which Indian cattle are most subject, and it has never, throughout this period, been necessary to seek the aid of a Veterinary Surgeon chiefly on the score of expense. Experienced native cowmen have been able to do all that was required, and though at the outset the loss of cattle may have been large, the cowmen after a few years' experience proved themselves very valuable veterinary assistants. Every farm should either have trained men of this stamp or experienced *salutris*, but with the latter there is a tendency to indulge in costly medicines, while the ordinary cowman works merely with simples.

Sheds and attendants.

On the principle that prevention is better than cure, all sick animals should be at once removed to the infirmary. Epidemics in India are of frequent occurrence and often very serious, and the speedy segregation of infected animals is of the greatest importance. All infectious or contagious diseases should be completely isolated and huts should be provided for the men in attendance on cattle suffering from them. This is a matter requiring much and constant supervision, owing to the difficulty of making a native understand that disease can be conveyed to other animals by himself, as well as by one animal to another. The attendants on sick cattle should be made to wash their hands frequently in strong disinfectants, and the infirmary should consist of an open shed on raised ground with a good well, plenty of shade, and a fodder supply close at hand, to avoid the necessity for healthy cattle being employed in bringing food and water to them. The infirmary should be at some distance from the cattle-lines, and on the outbreak of an epidemic, it is best to segregate the animals which have stood close to infected ones and to remove them to some distance from those actually infected: the standings being at the same time thoroughly cleansed and freely sprinkled with quick-lime.

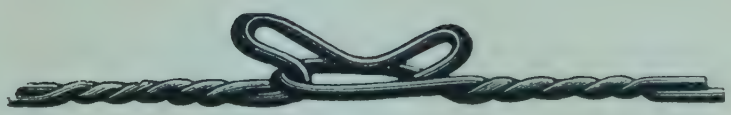
A few of the most prevalent diseases and the treatment which has been followed successfully at Allahabad are described below, and though this treatment may not be quite correct from a veterinary point of view, it has been found to answer very fairly in practice.

Pregnancy.

The chief indication of this condition is the cessation of the æstrum, and there is an improvement in the cow's condition with the disappearance of the inclination for the bull. There is also a distension and hanging of the abdomen, and a larger udder. The mucous membranes of the *vulva* and *vagina* are increased, as also their secretion. At about the fifth month, the fœtus can be distinctly felt by pressing the cow's right side, and later on the movements of the calf can be observed without any manipulation. Cows should be taken great care of at this time, and should not be allowed to mix with the herd but grazed separately, as injuries at this stage are likely to result in the premature birth of the calf.

Parturition.

When a cow is about to calve, the udder swells with the flow of milk into it; there is a discharge of thick mucous from the vulval opening, the vulva and the folds of the integument appearing swollen. Depressions near the root of the tail indicate the immediate approach of calving. When about to calve, a cow always separates herself from the herd and selects a shady place. She is then in great pain and



CROSS HEAD.

ADJUSTABLE.

SINGLE END SINGLE LOOP BANDS.

The Tie.

discomfort ; the orifice of the *uterus* enlarges and a watery fluid exudes. She sits and stands alternately at frequent intervals and is restless. She should not, at this time, be disturbed, and no dog should be allowed to approach her. The labour pains gradually increase in severity, and then a sort of water-bladder protrudes from the opening. The forefeet of the calf appear shortly after this and, if nothing has gone wrong, the head is seen resting on the forelegs. The calf's body is gradually expelled, and finally falls slowly to the ground. It is always advisable to have a plentiful supply of bedding on the floor of the stall to avoid the possibility of injury to the calf. Parturition generally occupies from one to two hours, but varies according to the constitution of the animals. The after-birth ordinarily comes away a few hours after the calf's birth, but sometimes from different causes it is not expelled for some days, and in rarer cases it does not come away, but decomposes in the uterus and passes away in that state.

Causes of retention of the after-birth.

Great care is needed in attending to the cleanliness of the cow after calving. The retention of the after-birth is generally caused by cold drinks given immediately after parturition, or it may be due to some entanglement or to want of effort on the cow's part owing to debility. On no account should it be allowed to remain for more than 24 hours, especially in summer in India, and every endeavour should be made to cause the cow to expel it. As quickly as possible after calving, the cow should be given bamboo leaves to eat, a small quantity of old *gur* and a mixture composed of 2 seers of old treacle, 2 *chattaks* of *ajwain*, and 2 *chattaks* of ginger, well boiled together and given when cool. This mixture should be given twice daily. The cow's food should be laxative, and for this reason a mash of bran, wheat and *mohwa* boiled together is often beneficial. When the fœtal membranes are retained it is serious, for they often decompose in the cavity of the uterus and cause great disorder in the system. The cow then gets fever, her milk yield is seriously affected, and it is some time before the cow can be induced to eat her full feed. There is consequently a considerable falling off in condition. When all natural means for securing the expulsion of the after-birth fail and there is fear of decomposition, the service of a gowálla who thoroughly understands his work (and there are many to be found in every city) should be secured, and he will introduce his hand and withdraw the after-birth. He should disinfect his hand thoroughly and grease it well before inserting it in the uterus. Unless the gowálla is an expert at this kind of work, the operation may prove more injurious than if the case were allowed to run its course. An experienced farm manager can easily detect a cow suffering from retention of the after-birth by the smell of the decomposd fœtal appendages, and in case the fœtal membranes become decomposed and fall from the cow, it is essential to segregate her from the herd and administer soft mashes to her for at least a fortnight. Purgatives should also be given — a seer and a half of ghi for a dose serving this purpose well, or two seers of old treacle daily.

Abortion and slipping of calves.

Cases of this nature occur very frequently among both cows and buffaloes, and farm managers are often disposed to regard them with indifference as ordinary incidents of no great importance, but the slighest reflection will satisfy every one that the success of dairying in India depends very largely on the careful and judicious management of cows as regards serving and calving. When a case of abortion threatens, the manager should at once refer to his record-book to see how long the cow has gone with calf, and he should endeavour to prevent the occurrence by giving the cow mild cooling tonics and keeping her at perfect rest. The reference to his record-book will enable him to determine whether the case is one of abortion or of premature birth. In cases of abortion or slipping of calves, the cow is in a restless state and frequently strains herself (in the vernacular, this is termed "*hool marthi*") and blood flows from the uterus. In premature birth, the fœtus lives for a longer or shorter time after expulsion. Abortion may be sporadic, epizootic or enzootic, and it varies in importance according to the stage of pregnancy of the animal. Thus in the case of cows which have only been pregnant for a short time, no apparent inconvenience is caused, but animals which are further advanced in pregnancy suffer more severely. In cases of abortion there is a greenish discharge from the vagina, the cow is very uneasy and fever is present. Later cases are accompanied by the ordinary sign of parturition. Abortion is generally due to one or other of the following causes : injury

of some kind, wrong or unsuitable purgatives; too frequently taking the bull; bad or excessive feeding; drinking impure water; cows mounting one another at graze; jumping over undulating or raviny ground as often happens at graze; excessive exposure to heat or cold, and eating certain descriptions of fodder especially. It sometimes arises from the cow's debility, and any cause which affects the constitutional condition of a pregnant cow is likely to produce it. Cases have been known where the discharge of firearms in a dairy yard by troops on a field-day has caused cows to abort. As abortion means serious loss to a farm — not only in the loss of the calf, but chiefly in the greatly diminished secretion of milk, efforts ought to be made to prevent it as far as possible. A rigid separation of the animals which have aborted from those pregnant is absolutely imperative.

Treatment. Administer purgatives :—Treacle (old) or old *gur*, 2 seers; *ajwain*, 2 chattaks; ginger, 2 chattaks; pipal ¼ oz.; and piparamore ½ oz. Mix well. This mixture is cathartic and cleansing: the diet should be laxative and stimulants should be given. If the fœtal membranes are not passed with the fœtus, they should be removed as soon as possible, but by natural means. The hand should not be inserted in the uterus in such cases. It is far better to allow the after-birth to decompose and pass away.

Cows which have aborted should not be allowed to mix with those which are pregnant. The natives of India are very careless in this respect, and even farm managers are apt to overlook the importance of this course. Instances have occurred of aborted cows being kept and fed in the same calving shed with other pregnant ones, with the consequence that the latter also aborted. It is imperative, therefore, that all affected animals should be strictly isolated and their stalls thoroughly disinfected, as well as their attendants' clothing. Cows have been known to abort repeatedly and at about the same stage of pregnancy on each occasion. As soon as such animals are discovered, it is advisable to weed them out.

Premature birth. Premature birth is due to almost the same influences as abortion. Particular care should be paid to cows about five or six months in calf. They should be kept completely apart from the dairy herd in order to avoid, as far as possible, the causes which give rise to premature birth. It is possible to rear calves prematurely born, but they require special care and attention, as they are deficient in heat-producing power and strength. As in parturition and abortion, the cow should be induced to expel the after-birth which, however, is often retained. Treatment — Purgatives (as in abortion) and laxative food.

Mammitis, or *Girgit*. This is an inflammation of the mammary gland and is of frequent occurrence among cows and buffaloes. It is, perhaps, next to rinderpest, the disease most to be dreaded, as it seriously affects the milk yield and completely cripples a dairy. Even if the disease is successfully combated, the loss caused by it is very considerable, as, while the udder is inflamed, the whole of the cow's milk must be destroyed. It is to be feared that farm managers do not sufficiently appreciate the importance of this branch of their work, and that they allow the milk of affected cows to be issued for consumption. Indeed, in private dairies and in those badly financed, this precaution is not taken, and the public suffer in consequence. There are four distinctly separate quarters of the gland: and the udder may be partially or completely affected. It is true that in cases where only one quarter is affected, the milk from the other three might be wholesome and issued for consumption, but it is wiser not to use it, so as to avoid the possibility of a mistake. This inflammation sets in sometimes directly after calving, but it also comes on some short time afterwards. The udders of newly-calved heifers are often inflamed before calving, and should be manipulated with hot castor-oil, and mere steaming is often beneficial. Mammitis is chiefly due to the following causes: exposure to cold when heated; imperfect milking; allowing milk to remain too long in the udder before milking; injuries of various kinds, some resulting from *pucka* standings; pinching the teats in the process of milking; obstructions to the flow of milk; washing the udder and leaving it wet, and also other specific disorders. It occurs frequently in the hot summer months.

Symptoms. The symptoms are: the gland is swollen, hard and painful when touched; the skin is red; and the cow often becomes lame in one of its hind limbs. The yield is

Photo-Block. Survey of India Offices, Calcutta

The clod-crusher, very useful for breaking up clods in dry weather.

decreased and the milk is curdled, and blood is generally intermixed with it. At milking, a thin watery fluid comes from the teats. When pus forms, the udder becomes soft and pits on pressure. The importance of attention to the udder cannot be over-estimated, and when purchasing cattle, farm managers should satisfy themselves that their udders are perfect in all four quarters and all their teats sound.

Treatment.

In many cases, newly calved heifers develop inflamed udders, but a little fomentation soon puts this right. Rub them with hot castor-oil three times a day. Steaming also has been found beneficial. In all cases, give a purgative (1½ seers of ghi) and 2 seers of old gur and 1 seer of *kála jírá* daily for a full grown cow for three days. Epsom salts should not be given, because it interferes with the milk yield. The animals should also be allowed nitre in their drinks. Care should be taken to remove the milk thoroughly, at intervals every day, either by hand-milking or with the teat syphon or the calf may be allowed free access. Foment freely and apply a belladonna poultice to the whole of the gland, by means of a wide bandage passing over the loins. Instances have occurred where the abscesses have burst of their own accord without the use of a lancet, but early puncture with the lancet has often been the means of saving the quarter. The cavity should be subsequently dressed with carbolic or wax ointment. If this disease is taken in hand in time and fomentations are resorted to without delay, the evil consequences may be averted.

Obstructions in teats.

In buffaloes especially, obstructions in the teats are frequently found. These can be easily detected when milking. They appear as nodules along the course of the duct, and while in some cases the flow of milk is more or less impeded, no milk whatever can be drawn from the teat. These nodules are generally small tumours or masses of curdled milk, and tend to produce mammitis. It is difficult to remove them. At fairs it is often extremely difficult to detect them in the teats of a cow in young (*i.e.;* before they are milked), but any experienced *gujar* or *gowálla* will find them out by running the teats through the finger and thumb. Cows which have obstructions should not be purchased, as the teats are either blind or will become so at the next calving.

The most frequent malformation is a perforated state of the teats. After impregnation, when the milk gland enlarges and in proper time produces milk, this cannot get out owing to the teats being blocked, and it remains in the milk channels—sometimes bringing on mammitis. The teat should be opened by an incision at its extremity and the milk should be drawn off regularly either by hand or by means of a milk-syphon. An abscess usually forms and the pus escapes with the milk. Many cases even of young heifers have been known where the teats were blind after the first calf—the mothers having suffered from the same defect. It would therefore appear that the disease can be transmitted by a cow to its progeny. Very serious loss has occurred from want of knowledge regarding the care that is essential for the udder and teats of a cow. It is generally a foregone conclusion that if a cow has a sore teat, the teat will become blind (*i.e.*, closed) and the udder being such a delicate organ, no attempt has been made to discover a remedy, either by incision or probing. Excellent cows have been known to lose as many as three of their teats and thus be almost valueless. If a cow should only lose one quarter and her milk yield be in consequence but very little decreased, the one blind teat reduces her value by about 30 per cent.

Causes of sore teats.

The following are the causes which generally give rise to sore teats and resultant imperforation; bad milking, *i. e.* placing the teat between the thumb and forefinger—the teats getting pinched, and pimples raised which gradually expand and contain pus. Lime spread on the floors of the stalls also raises blisters, which subsequently become sores. Failure to thoroughly wash and clean the colostrum from the udder and teats of newly-calved cows also give sore teats. Again, blood is often mixed with the milk drawn from a quarter of the udder, the teat being slightly inflamed. In such a case, a *táwa* (a native frypan) should be heated red-hot, and the cow's milk drawn off on to it, the *táwa* being held close up to the teat. The effect of this is practically to steam the teat, and the process is very beneficial. In all cases, however, where a cow's udder or teats are affected, a purgative should be promptly administered: and the best

Diseases of horned cattle and their treatment.

Treatment.

for this purpose is a seer and a quarter of ghi with four ounces of *kála jírá* well mixed. The udder and teats should be manipulated with hot castor-oil several times daily, and fomented with water in which *nim* leaves have been boiled. Another cause of sore teats is the occasional biting of the nipples by the calves.

Inversion of the vagina.

This is of common occurrence with milch cattle and generally accompanies the prolapse of the uterus. A red tumour hangs from the vulval opening. The more serious cases are termed chronic. It is not difficult to return the part after cleansing: but the trouble is to prevent it from protruding again. Many instances can be quoted where, from neglect, crows and other birds have been allowed to peck at the protrusion and no remedy has been applied for some time. The Panjabi *gujars* have considerable experience in cases of this kind, and their treatment is to thoroughly wash and cleanse the parts first with water and then with brandy, if available. The hind part of the animal's body is raised, so as to facilitate the return of the part and to prevent its expulsion. The protruding vagina is supported on a clean cloth, and is gradually pushed inwards with the closed fist. It is prevented from returning by pressure on the cow's loins and by the distraction of her attention. A truss is then applied, and this, as a rule, prevents the organ again protruding. Some also insert a glass bottle to keep the vagina in its place. Cows subject to this complaint should be disposed of, for, apart from the trouble of looking after them, their milk yield is greatly interfered with. It occurs both before and after calving and has been known in some cases to cause premature birth.

Sterility.

Cases of sterility occur among heifers as well as among cows, but they are not so frequent among buffaloes. Well-bred calves and those in good condition are especially affected. When a heifer once retains, she is generally all right afterwards. Cows have been served time after time without retaining. These are termed "*baila*" by the natives, and should be weeded out without hesitation. In the case of heifers in an excessively fat condition, the ration should be reduced and the bull changed. Good results have also been obtained by giving cooling draughts after the animal has been served. It is often, perhaps, due to young bulls being allowed to run loose with the heifer calves and attempting to mount them when very young. Buffalo heifers have been known to become sterile by young bull-calves (of cows) being allowed to mount them. This is very dangerous, and for this reason buffalo-calves should be kept apart. Sterility is also said to be due to some imperviousness of the generative passages such as result from inflammation caused by scrofulous disease and to morbid growths.

Tumours and wounds.

Tumours are really swellings which are generally of a circumscribed character, either protruding above the surface or eating into the flesh. They are to be found of various sizes in calves, more especially the younger ones, and in almost every case disappear in the natural course of things. Where, however, tumours (or, perhaps rightly, abscesses) appear containing pus, they ought to be lanced, the pus removed and the cavity dressed with carbolic or wax ointment — the latter being composed of wax, cocoanut oil, vaseline and a little sulphate of copper. In old cattle, excision is perhaps the only means of relief, and all morbid matter should be removed, but in calves it is safer to allow them to disappear naturally.

Wounds in cattle heal rapidly as a rule, if they are carefully washed and disinfected and all foreign matter removed. The first step in the treatment is to check hæmorrhage if present, which can be easily done, and to keep off flies which irritate wounds so much in India. Phenyle is sometimes used both as a disinfectant and as a safeguard against flies: but *nim* oil will serve the latter purpose just as effectually and *nim* tea (the leaves of the *nim* tree boiled in water) fomentations are extremely valuable alike for disinfecting, cleansing and healing wounds. All sores on the body or udder should be washed twice or thrice daily with *nim* tea and treated with wax ointment.

Skin diseases. Warts.

Warts frequently produce tumours of various sizes; in fact, many of the tumours seen on cattle were originally warts. Owing to friction, they ulcerate and soon spread over the body of the animal, forming large, raw fungus-like masses on the surface. Dirt, and milk in the case of the younger calves, seem to be the exciting

influences. Some advise the removal of the warts by ligatures, but it is perhaps safer to destroy them by strong caustic agents.

Ringworm is another disease which is more prevalent among calves and which has been known at times to spread throughout the entire young stock of a dairy farm in a very short time. When of a virulent type, it tends to retard the growth of the younger calves. Calves are often seen covered from head to foot with thin crusts or scabs of various sizes, and often no notice is taken of them until the disease spreads throughout the herd. Ringworm impairs the condition of young stock to a very great extent. Ringworm.

Treatment:—Remove the crusts and destroy them; and then dress the exposed parts with nitrate of mercury ointment, nitrate of silver and diluted sulphuric acid. Turpentine and sulphate of copper applied three times a day is also a good remedy. It should, however, be applied as soon as the crusts appear, and not when the disease has spread throughout the herd. All animals suffering from ringworm should be isolated.

Mange attacks young buffalo calves chiefly from six weeks to six months old: but even older animals suffer. The disease very probably originates with the mother's milk. The bodies of young buffalo-calves are sometimes a mass of raw flesh from the ravages of this disease: and it may be safely said that the large percentage of deaths among buffalo-calves is attributable to this disease; yet it is surprising how careless farm managers are in regard to its treatment. All affected animals should be isolated and special attendants told off to supervise their feed and keep. Where calves are located in small numbers in sheds, instead of being kept together in a yard, mange does not cause so much havoc, and the danger of any other contagious or infectious disease spreading is also minimised. The calves should be washed with country soap and turpentine, and sulphur and sulphate of copper should be applied once daily to the affected parts. The use of phenyle is advised by some, but the above application has been found to act better. In the experience of the authors, no disease tends so much to retard the growth and advancement of young stock, and it should be treated as one of their greatest enemies. Mange.

Cowpox is often confounded with other diseases. When asked what has happened to an animal which is attacked with this disease, the native *gowálla* generally replies "*Kya jáné kya hogaiya!*" The first symptom is a redness over certain parts of the body and subsequently circumscribed in patches over the mammary gland and teats. Small hard nodules or lumps appear on the reddened parts. After about eight or ten days, the nodules generally burst and exude pus. They may, however, dry up without bursting. The disease lasts for about two or three weeks according to severity. Instances have been known of cows suffering from it being allowed to remain with the herd instead of being isolated, simply because the *gowálla* or head milk-man had assured the manager that he had seen many similar cases which recovered quickly. He termed the disease "*garmi*" implying that it was caused through heat. It brings on high fever, saliva falls profusely from the mouth and diarrhœa is a frequent accompaniment. Cow-pox.

Give purgatives—Epsom salts (2 lbs. for a full-grown cow): and laxative food. See that the milk is drawn off carefully and regularly, and that the cow is not permitted to retain her milk. On no account should the milk of affected animals be issued for consumption. Treatment.

In India, buffaloes are more subject than cows to lousiness: and it can be readily understood how seriously this condition affects the growth of an animal as well as its milk yield. It also greatly retards the development of young stock. The vermin attack all classes of buffaloes alike, but are perhaps more numerously found in debilitated cattle. The nits can be seen on the hair of the animal and much trouble will be saved if the hairs are cut off in time and burnt. Lice.

Dress with tobacco water and rub all the affected parts with it daily. Cattle are chiefly attacked in the winter months when it is advisable to remove all the hair with a pair of scissors. A solution of phenyle has also proved effective in removing the lice, but the solution should not be so strong as to blister the buffalo's skin. Kerosine oil has also proved effective, but it should be used cautiously. Treatment.

Diseases of horned cattle and their treatment.

Fracture of the horn. Cases of fracture of the horn are of frequent occurrence among all horned cattle, more especially among cows and bullocks. Young animals which are frequently frolicking and fighting meet with most accidents of this nature. When both core and horn have been broken hæmorrhage will be profuse, and though it can be easily restrained, old cows or bullocks are never the same animals again, as complications usually set in which interfere seriously with them when exposed to heat. If the core is not damaged, the matter can easily be remedied. Instances have been known of the horn having been completely knocked off, and growing again when immediately replaced and carefully bandaged. Fractures unite more readily in young than in old cattle.

Treatment. Wrap a broad cloth round the horn loosely, and apply *nim* oil freely. It is extremely difficult to treat horned cattle for fractures owing to the inability to keep them quiet and at rest. Slings may be advised, but they interfere with the digestion of the animal and are even more injurious in the case of milch cattle, and it would therefore be better not to resort to their use.

Dislocation of patella. Dislocation of the patella is most frequent among working cattle and in most cases the animal is seldom or ever sound again. The limb is drawn backwards and maintained in that position. It is generally due to the animal falling backwards, as into a ditch. This frequently occurs when washing cows on brick-floored stalls, when they slip into the drain behind. Bullocks should not be purchased with this defect, although it is sometimes difficult to detect it. The natives often, by mistake, call it *jànak* or *batàs* (rheumatism).

Treatment. Draw the limb forward by a hobble fastened round the fetlock with a rope attached to it and with a band passed round the neck of the animal. Pressure is applied until the bone slips into its place. The animal should be kept tied up, but it is difficult to keep the limb in its proper position. These accidents are serious, but with a little care and attention they can easily be avoided; in fact, it is one of that class of accidents in regard to which prevention is better than cure.

Fetlock sprain. This form of injury is more frequent among working cattle and generally occurs when bullocks are trotted. It is sometimes caused by the overgrowth of the hoofs.

Treatment. Bandage and pour cold water continually on the part for a few days, or apply a *Kulthi* poultice. This has been found to answer well in all cases of sprain.

Hip sprain. Animals affected with hip sprain bend or turn the injured limb when at rest, and the haunch is seen to droop on the injured side: the animal is unable to raise its thigh and cannot advance its leg; the hoof is therefore dragged along the ground. The animal is in great pain, and rather than move, it will remain standing for several hours. In chronic cases, instances have been observed where the quarter affected has wasted away. Hardly a case has been known of an animal thoroughly recovering from hip sprain. Buffaloes seldom meet with accidents of this kind. Hip sprain is caused by beasts mounting each other when at graze, or by their slipping on the bricked floors of their stalls while being washed and often when they fall in trucks while being conveyed by rail.

Treatment. There is really no remedy for this except the knife, but attempts have been made to give relief to the animal by fomentations of various kinds.

Parturient fever. Parturient fever comes on after calving through injuries of the genital organs and it frequently arises from the putrefaction and decomposition of genital products. In some cases, however, animals have been known to have had high fever before calving. It also occurs in severe abortion cases. The retention of fœtal membranes, decomposition of the fœtus, or the introduction of the hand of a *gowálla* contaminated with putrescent matter are also causes which give rise to it. Often, in the same calving shed, a *gowálla*, who had first been attending a cow with the same disease, has thoughtlessly been directed to insert his hand into the womb of a cow and remove the after-birth —it is needless to say with what result. The disease appears within a week of calving and is accompanied by inflammation of the womb. As the disease advances, the temperature falls, respiration quickens, and the cow appears to lose the use of her hind quarters. They are always weak about the loins, and if pressure is applied there, the cow bends. The disease is very infectious, and instances can be quoted, to

the extreme regret of the authors, of cow after cow dying in the same calving shed before the cause was discovered. Cases occur more frequently among buffaloes than among cows, and they seem to suffer more, owing probably to their being more delicate.

Disinfect the discharges, as also the hands and clothes of the operator; inject a solution of carbolic acid into the uterus; apply glycerine and carbolic acid directly to any ulcers within reach; administer stimulants freely; feed on light gruels and laxative food. All carcases of fatal cases should be burnt and the standings of the cow excavated and disinfected. All cases of fever in the calving shed should be immediately isolated. Cows are often transferred from the calving shed to the milking yard before the disease has had time to make its appearance; and to avoid any risk from this, it is better to allow cows to remain in the calving shed for at least ten days after they have calved. Treatment.

Parturient apoplexy is peculiar to milch cattle and generally occurs shortly after or immediately before calving. All heavy milkers are subject to it. On the Allahabad farm about six cases occurred, five of them being buffaloes—a fact which points to buffaloes being more frequently attacked than cows. Milch cattle have been known to withstand and recover from a first attack, and at the next calving to succumb to a second one. Of course, in this as in parturient fever, the milk dries up completely. The symptoms are restlessness and quick breathing, and often in the last stages the cow keeps her mouth open and her tongue out, generally standing still in one place; there is a cessation of appetite and rumination stops. After a short time, the hind limbs seem to be paralysed, the cow has no power in them and falls. After this, a cow rarely rises again, although she may make several attempts to do so; her eyes become bloodshot and fixed, and she appears to be very wild. Her pulse beats faster and weaker and finally is imperceptible; she dashes her head from side to side in the delirium produced by her agony. Cattle in this state have been known to break away and rush into tanks where they have remained till they died. Parturient apoplexy.

Careful nursing is requisite, and purgatives and cooling drinks should be administered. Gruel also should be forced down the throat in order to maintain the animal's strength. It is said to be inadvisable to draw off the milk of a cow from this disease; but, like all other sick cattle, cases of this complaint should be rigidly isolated, and special attendants should be told off for their care and keep. Treatment.

Outbreaks of splenic fever are ordinarily traceable to contagion, and it attacks slaughter cattle perhaps more frequently than dairy animals. The former generally get only a coarse dry feed, while the latter invariably receive a laxative diet. It is, however, due sometimes to bad food; at others to an over-nutritious diet, and at times again to sudden changes of diet or other influences. Its appearance in a herd is sudden and it is very fatal, causing immense havoc in an extremely short time. Cattle sent out to graze at 8 A.M. have been found dead by 2 P.M. The disease somewhat resembles hoven, and is ordinarily confounded with it. In its earlier stages it is scarcely perceptible, and by the time its presence is recognized the animal is at death's door; but though in the great majority of cases it runs its course very rapidly, some animals hold out for as long as two days. The symptoms are a profuse flow of saliva, a very rapid respiration and severe pains in the abdomen. The internal temperature is somewhat high, as the animal perspires profusely. Staggering and muscular twitchings on the body are very perceptible; and the urine frequently contains blood. The disease advances so rapidly and is diagnosed so late that many animals die before any treatment can be determined upon. When it is recognised, a strong purgative should be administered. As the animal approaches death, a great quantity of water exudes from the mouth. Dissected carcases of animals dying from this disease exhibit the spleen enormously distended, the gall bladder full and the contents of the bladder mixed with blood. All animals affected with this disease should be rigidly isolated and their carcases invariably burnt. Splenic fever.

Nearly all cases of eye defects in cattle are due to injuries generally received while at graze; and it is surprising to observe the indifference shown by both farm managers and attendants to the risks to which cattle are exposed in this respect; and it is usually only when the injury is past remedy that it is discovered. Eye defects.

Diseases of horned cattle and their treatment.

Simple ophthalmia is caused by the entrance of foreign matter into the eye, by injuries and by exposure. It is readily detected, as the eye closes from the thickening of the eyelids and from its intolerance of light and tears trickle in quick succession down the animal's cheek.

Treatment. The eye should be fomented and dressed with a solution of sub-acetate of lead; and then protected from the light. Where the injury to the eye is only slight, a solution of salt and water squirted into the eye is often effective, while in the more acute cases calomel is used.

Blood in the urine. In this disorder blood, in a coagulated form, is passed in the urine, and the animal, when pressed about the loins, manifests pain. The disorder is generally the result of injuries, congestion or ulceration of the kidneys or urinary passages, the entry of acrid plants into the stomach, straining, or being struck on the loins with the cowherd's stick while at graze. Falls, and cows leaping on each other, also produce it. The cow stands in a heap with arched back, and staggers when she moves; she passes her urine in small quantities and generally suffers from fever.

Treatment. Cold applications to the loins and sulphuric acid to stop the blood. A little glycerine or linseed oil is also very useful. The diet should be very laxative.

Hair balls. Hair balls are very peculiar, and to one who has had no experience of them, it seems hardly credible that things like hair balls could come from the rumen through the cow's mouth. The natives call them "*garwah*"; probably from the sound the cow makes when troubled with one. It is of considerable interest to know how these balls are formed, and how they affect a cow's condition. When in health and happy, calves and even full-grown cattle are often seen licking themselves or each other and the hair is taken in by the tongue and swallowed. These hairs accumulate in the stomach and form themselves into a ball. They vary in size and weight from 2 ounces upwards. When they are very large, the animal is liable to be choked, but if of moderate size, they are passed up into the mouth and ejected. It is wonderful to see how well the hairs are woven together. There is no known remedy for these hair balls, beyond the usual native charm.

Colic. The symptoms of colic are very similar to those of other abdominal diseases. Bullocks are more prone to it than milch cattle. When an animal gets an attack, it is seen to strike its belly with its feet, is very restless, getting up and lying down frequently, and in the latter position turning its head round and laying its nostrils near the seat of pain. The urine is passed frequently in small quantities. When in great pain, an animal will moan and grind its teeth. Colic is often caused by a sudden change of diet, the drinking of cold water immediately after feeding, over-feeding, or the admission of rank fodder into the stomach.

Treatment. Administer a bottle of country liquor (*phul shrâb*), and give a strong purgative.

Diarrhœa. It is extremely difficult to correctly diagnose diarrhœa in cattle, as the *fæces* are excessively fluid. In a case which came under the authors' observation, a so-called expert was requested to report upon a disease which had carried off in less than a month over 400 head of cattle. The disease was rinderpest, but the expert pronounced it diarrhœa, and he was only convinced by the opinion of other experts. If, therefore, experts can err in this way, it is evident that the inexperienced must find it very difficult to correctly distinguish this disease. Innumerable instances have occurred in which calves suffering from rinderpest have been treated for diarrhœa. When, in chronic cases, the intestines are inflamed, the disease resembles dysentery and it ends as such if uncontrolled for too long a time. An animal suffering from diarrhœa eats but little, having little or no appetite, and the rumination is imperfect and irregular. It stands aloof from the rest of the herd with back arched, and its urine is scanty. Bad pasture and certain plants, such as castor-oil plants, and coarse, badly-served food are likely to bring on the disease, as also excess or a sudden change of food. Immediate change from dry to rank grass food, certain kinds of fodder grasses, bad silage, and exposure to cold are also responsible in many cases. In buffalo calves, worms generally produce diarrhœa.

Careful nursing, laxative food and stimulants; water in small quantities only; starch gruel as an astringent beverage; *katila* and barley flour also, mixed in

separated milk, will give the animal ease. The following treatment has also been found useful: chalk 1 oz., catechu 1 oz., opium 4 drs., gum 1 oz., mixed and given in barley flour balls.

Dysentery is due to inflammation of the membranes of the bowels accompanied by ulceration. It is often mistaken for rinderpest, and *vice versâ*. It may of course have developed out of diarrhœa or have arisen from exposure to cold. The animal stands with its body twisted up, its back arched and, in acute forms, after constant straining, merely passes a small quantity of slimy, watery matter mixed with a little blood. Dysentery.

Careful nursing and gruel, made of linseed, barley-flour, and ground pepper boiled together. For drink, give separated milk mixed with parched barley meal. Treatment.

Cattle may often be seen in herds, which, though fed and cared for exactly as the others, remain in very poor condition. Again, some have depraved appetites and their rumination is imperfect, though they have no apparent disease. They generally assume a tucked-up miserable appearance, and fall off in flesh rapidly. These conditions can safely be attributed to indigestion in one or other of its forms. Among the causes which give rise to indigestion are irregular and bad feeding, want of exercise, exposure and defective sanitary arrangements. The coats of the animals are nearly always affected, look dirty, dry and staring, and are never sleek like those of healthy stock. The animal becomes altogether unthrifty and when slaughtered, its condition is often traced to some internal organic change of long standing and unusual character. Indigestion.

Give purgatives and stimulants, change the diet, give *gur* and *hemp* in flour balls once a week, and rub the animal's mouth well with salt every week. Indigestion may be due to the conical papillæ in the mouth having grown too long, and salt applied in this way is a good remedy. Treatment.

The presence of foreign bodies in the rumen and recticulum is also another cause of the indigestion frequently seen in cattle and produces irregular rumination, very poor appetite, and poor and delicate condition. When the foreign bodies get entangled in the stomachic openings, the case is very serious. Injury done by sharp bodies internally often bring on inflammation. Cows have been known to swallow needles accidentally and these have passed out through the leg or some other part of the body. Foreign bodies in rumen and recticulum.

As it is impossible to tell when an animal swallows a foreign objection or the character of the object, it is only when suspicion is aroused by her condition that treatment can be commenced, and the same treatment should then be adopted as in cases of indigestion. Treatment.

Cattle may be poisoned in various ways. Many instances of deliberate poisoning by natives have occurred, and whenever it is intended to establish a dairy farm, the encouragement one gets is—"Your cattle are sure to be poisoned by the natives!" This poisoning is generally done by the former milk-vendors or by chamars who want the hides of the animals. It is a very great mistake to sell the hides of diseased carcases, not only on account of the risk of infection, but because when they are sold to a single contractor, it is to his interest to get as many hides as he can, and he is tempted to resort to poisoning. This is generally effected by piercing the flesh and inserting the poison in the puncture. Allahabad was said to be noted for this "trick of the trade," but, though strange, it must be admitted that during the thirteen years of its existence, the dairy farm has not had a single case of poisoning. Poisoning is also due to other causes, *e.g.*, overdoses of medicine, the presence of deleterious matters in the food, poisonous weeds and plant foliage, withered crops in times of drought, and the aftermath of *impi* or *karbi* during the hot season, poisonous seeds in oil-cakes, and the leaves of the castor-oil plant. As regards crops and the aftermath of *sorghum* crops during the hot summer months, cases have happened where sheep and cattle were turned on to graze such crops and the former almost instantly began to drop one after the other, and the cattle followed. They were all treated in time, or the loss would have been very serious. It behoves farm managers, when there is the slightest suspicion, to investigate the cause and treat promptly. The points to be observed are the diet, and the pasture, and whether any tampering with the body has occurred. Cattle poisoning.

Diseases of horned cattle and their treatment.

Treatment. Give wheat flour mixed with the white of eggs and made into balls and administer emetics. Also give strong purgatives; 1½ seer ghi or 2 lbs. Epsom salts for a full-grown animal. The former is perhaps the better.

Hoven. Hoven may perhaps be considered the most frequent complaint among cattle. Some are naturally subject to it and eventually die from it. Buffaloes appear to suffer more severely than cows. If taken in time, there is very little danger, but native attendants are so indifferent about any disease, that they fail to report animals as sick until they are nearly dead.

The symptoms of the disease are extreme restlessness, kicking at the belly, frequent getting up and lying down, the stoppage of rumination, the refusal of food, the back arched, the abdomen distended, a free flow of saliva, eyes swollen and staring, and a swelling on the left side greater than elsewhere, which, if tapped with the finger, sounds like a drum. If no remedy is applied, the disease increases in severity until the animal falls and death occurs owing probably to rupture of the rumen, suffocation, or noxious gases. The causes are over-eating, too rank green food or grain, constipation, feeding green fodder saturated with dew, any sudden change of diet from dry to green or green to dry, and decreased secretion of saliva.

Treatment. Give at once one or two bottles of country liquor of the best quality mixed with an ounce of pepper, and administer purgatives or an enema. As a last means of saving the animal's life, puncture the left side at a point equally distant from the hip, last rib, and loin.

Rupture of the rumen. Rupture of the rumen often occurs as explained in the case of hoven, and also as the result of some injury. An animal falling when the abdomen is full is liable to rupture. Washing cows on bricked floors after they have been fed is very risky, as if they fall, rupture of the rumen is very likely to occur. Many such cases have happened.

Treatment. No remedy is known to the authors, but in order to save the carcase, an animal with ruptured rumen should, where Mahomedan milkers exist, be slaughtered.

A disease peculiar to calves. A disease peculiar to calves appeared on several occasions with varying severity. It often carried away many young calves before it was detected and, till a few years ago, it was not considered contagious. The buccal membrane sloughs in patches of considerable size, chiefly on the gums, against the teeth, and on the tongue. Diarrhœa always accompanies it, and this is why the native milkmen are inclined to treat it with indifference, as they imagine the diarrhœa to be due to the calf drinking too much milk, or to some disturbed condition of the mother. In many cases blood is passed with the motion, and if it is summer time the natives attribute it to the extreme heat. It is, however, very probably due to the ulcers spreading to the intestines. The mouths of calves suffering from diarrhœa should always be examined for ulcers—if none exist, then it is simple diarrhœa. In any case, calves affected should be rigidly isolated and their mothers also, if the calves suck them. Cases have occurred where almost the entire stock of calves has been affected by neglect to isolate. The mothers have not been known to take the disease, and it is therefore assumed that it is one peculiar to calves. Its causes have not yet been discovered, but in the cases which came under the authors' observation it was probably due to contagion. The symptoms are — a swelling of the cheeks and mouth, and a smacking of the lips, saliva falling from the mouth: in acute cases the calves refuse to suck their mothers, the mouth is open and the respiration quick, ulcers form in the mouth and, in the more severe cases, blood mixes with the matter passed from it.

Treatment. The mouth should be washed with a solution of alum, and a small dose of sulphuric acid and ghi given as a purgative; or 4 ounces of Epsom salts.

Scour in calves. Scour is generally due to the calves not digesting milk, and their stomachs becoming laden with a mass of hard curd, which sets up irritation. Very young buffalos-calves require good nursing and careful attention, as they are very prone to attacks. The disease frequently commences with constipation, and this is followed by violent diarrhœa. If not promptly treated, they invariably succumb.

Treatment. Give a purgative of oil or *ghi*, (about 8 oz.) and feed with linseed gruel mixed with a small quantity of pepper and parched-barley meal. In the buffalos-calves especially, worms are the chief cause of the violent diarrhœa, and if the treatment is not prompt, the results are always serious. Many remedies have been tried, but the follow-

ing have been found the most effective. *Nim* leaves ground with salt and *nim* oil, and administered to the calves while sucking their mothers, by drawing their mouths away after a second or two. The worms having relished the short draught of milk are ready for more: but they get the mixture instead, and next day (often, even, the same day) they leave the calf in great quantities. Worms retard the growth of calves at a time when any impairment of health tells most seriously upon their constitution and so checks their later development into full growth. When mature, such animals are always in poor condition with hard and dry skins.

Rupture of the spleen.

Rupture of the spleen is not of very common occurrence and is caused by injuries, blows, falls, etc. Its symptoms are abdominal irritation accompanied by internal hæmorrhage and the disease is not amenable to treatment as death generally supervenes rapidly.

Enlargement of the conical papillæ in the mouths and on the tongues of cattle.

An animal is caused great inconvenience by these growths. If the animal is in poor condition, the growth is very long and the animal is very much hurt while eating. In working cattle especially, a depraved appetite and a constant flow of saliva from the mouth occur. They consume their food, but are unthrifty, and partially masticated food is ejected in masses from the mouth. Cattle in this condition are always distressed, and their coats are dry and hard. The cause can at once be detected on opening the animal's mouth. Right at the back of the tongue is a large blister-like lump and the papillæ on the inside of the cheeks are large and pointed.

When the disease is not too far advanced, the constant application of salt to the mouth and tongue will give relief: but if the papillæ are too long, they must be cut and the lump on the tongue branded with a hot iron, after which the parts operated upon should be rubbed with ground turmeric and water made into a pulp. A bi-weekly application of salt to these parts should be continued for about a fortnight, by which time the improvement in the animal's condition will be very marked. Besides the salt which is given to them in their food, cattle, especially draught bullocks, should have their mouths well rubbed with salt at least once a fortnight, as in addition to keeping down the growth of the papillæ it improves their appetite. In cases of enlarged papillæ, purgatives and laxative food are essential.

Impaction of the rumen.

This is so like "hoven" as often to be mistaken for it. It attacks working bullocks and dry milch cattle more frequently than cows in milk. Some grains and fodder, *e.g.*, millet seed, *senji* and *maina* plants, are more likely to cause it than others; but it is often brought on by any feed which the animal devours greedily and eats to excess. Its symptoms are duliness and pain, a small and rapid pulse, and a swollen abdomen, the distension being greatest on the left side, though on percussion no sound is perceptible as in "hoven"; on the contrary, it pits on pressure. An affected animal lies on its right side. There is obstinate constipation and in the later stages of the disease hoven generally sets in. The respiration becomes affected, the animal grinds its teeth from pain and seldom lies down, standing with protruded neck and arched back. When inflammation sets in, the animal exhibits pain on the left side being pressed.

Treatment.

Rub the body and especially the loins with mustard oil and salt (or a little *sundri*) mixed, and give strong purgatives. A bottle of country liquor of the best quality should be given at once, and then a mixture of *ghi* (1½ seers) and ground pepper (1 oz.) after which a dose of old *gur* (2 seers) or old treacle with 4 ounces of ajwain should be given twice a day. No food whatever should be given. In some cases a cure has been effected by throwing the animals into water whereby vomition is brought about.

Impaction of the omasum or staggers.

All cases of constipation are not serious, and obstinate constipation is not always due to impaction of the omasum. It is often brought on by gastric inflammation. This is evidenced by the fact that on opening carcases, the entrails will in some cases be found hard, and in others moister than usual. Staggers are generally due to feeding on indigestible materials, *e.g.*, sapless hay or over-dried chaff. The symptoms somewhat resemble those of the earlier stages of rinderpest; the dung passes away in small quantities, resembling camel's dung, of the size of marbles, and covered with lime. The pulse is hard and quick, there is severe pain in the abdomen and the animal is consequently very dull. Inexperienced persons are apt to confound

staggers with *pleuro-pneumonia*. The brain in the later phases becomes affected, the animal staggers, its eyes grow swollen and staring, and generally it rushes wildly about with mouth open and tongue hanging out.

Treatment. Strong purgatives and stimulants should be given, both internally and externally.

Foot and mouth disease. This is a specific eruptive disorder which may occur on any mucous membrane, but especially affects that of the mouth. It is not so fatal in India as it is in Europe, and it may be asserted with confidence that, when an affected animal becomes lame, it will not die from it. If death occurs, it comes within three or four days, which is the period of incubation. The symptoms are high temperature; the animal gets tucked up, and refuses food; rumination stops, the mouth is closed and the lips are tightly set. Shivering and grinding of the teeth occur at frequent intervals: the bowels are constipated, the breath is fœtid, and the animal sluggish. After about two days, the characteristic eruptions appear; and it is only now that the farm manager realises that the animal is sick and examines the mouth. He finds the mouth, dental pad, tongue, palate, and sometimes the nostrils, covered with eruptions the size of a shilling and larger, which break and become red as if the skin had been pealed off and the raw flesh exposed. The saliva discharge increases and there is a smacking of the lips. Vesicles develop occasionally, but rarely, on the udders of cows and affect the teats. Before the feet get sore, the animal is in great pain, is restless and continually lifts and jerks its feet. It is not always possible to detect the disease in slaughter cattle until the animals become lame, but if cases of striking of the feet and the collection of flies on them are immediately treated with suspicion, mistakes will not easily be made. At this stage, the animal arches its back and brings its four feet almost together, the coronet swells and ulcers appear between the digits and often above the fetlocks. The animal is now dead lame, and milch cows at this stage give little or no milk.

Foot and mouth disease sometimes assumes a more virulent type: and, as stated above, in severe cases, the animals die before the eruption appears. The disease is one to be most carefully guarded against in a dairy as, although not generally fatal, it seriously affects the produce of the dairy. Not only is the milk of affected animals unfit for consumption, but in the acute forms of the disease, the cattle go off milk altogether. The Indian *gowálla*, however, disposes of the milk of his cows even when they are suffering from this disease, as there is apparently no legal restriction on its disposal.

Affected animals recover generally in from two to three weeks, but the feet sometimes remain bad for months, while in some cases the hoofs are completely destroyed. In acute cases, abortion and premature birth frequently occur among milch cattle. As illustrating the contagious and infectious nature of the disease, the following experience may be cited. On two or three occasions, when foot and mouth disease had broken out in a dairy, the pigs (about 400 or 500), which were fed on the milk, contracted the disease within 24 hours. On another occasion, the flushings of the Dairy were passed through the pig-tyes to wash them out, and within a day or two the whole of the pigs were affected. Every precaution is now taken to avoid the possibility of similar contamination.

Foot and mouth disease is perhaps the most infectious and contagious disease known. The virus may be conveyed by the attendants or by appliances; it may be carried by the wind or taken up by contagion as when animals pass over or along public roads on their way to and from their grazing ground. A short time ago some students undergoing training on the Allahabad farm allowed a few calves to be enclosed in the dairy cattle yard for only a few hours, until they were seen by the farm manager, who had them instantly removed and the place disinfected. The students laughed incredulously when he told them that he feared the whole of his dairy herd would be attacked by the disease, but within the next three days, to their surprise, no less than 200 animals were affected, notwithstanding the short time the calves were in the yard and the subsequent disinfecting of the place.

The severity with which the disease attacks English or half-bred English stock in India is very noticeable. Almost every joint becomes covered with the eruptions and abscesses are of frequent occurrence. The disease finally ends in lung complications

and few animals escape. Another peculiarity with foreign cattle is that they are attacked by disease before the ordinary country stock. If sanitary measures are not enforced strictly, the disease may assume its severest form. It is said that the disease is communicable to man through the milk, and that children are thus liable to attacks. The flesh, however, is not injurious.

Treatment. Divide the herd into diseased, suspected and unsuspected lots. Give all affected animals a purgative—2 lbs Epsom salts to a buffalo and 1½ lbs. to a cow. If not moved, give 2 seers of old treacle twice a day for three days. The diet should be soft and the mouth washed with a solution of alum. Stockholm tar should be applied daily to the digits when the feet are sore. The cattle should be enclosed on puddled soil, sprinkled with lime and sulphate of copper. The cattle should remain on this day and night except when being fed; it prevents the flies from troubling them and the ulcers or sores heal more rapidly.

Rinderpest. Rinderpest is the most formidable specific disease of cattle known, and requires the most active measures of repression. It is of an extremely infectious and contagious character, and very deadly. It also affects sheep. Its period of incubation varies considerably—from four to fourteen days. The first indication is a rise of the internal temperature about twenty-four hours before any other symptom shows. At first the animals are frequently constipated, and pass their dung in small quantities, like that of a camel, and covered with slime. Only one thoroughly experienced can detect the disease at this stage without taking the animal's temperature, as it continues to take its food. The acrid tears which trickle profusely down the face from one or both eyes are a very sure indication, especially if they cause the removal of the cuticle. These tears differ from natural tears; and on rubbing the part over which they have passed the top skin comes off. Whenever rinderpest exists in a district—a fact easily ascertained—all animals that are affected with these tears should be placed under observation. The tears may be due to other causes, but it is wiser to err on the right side, and if, after a day or two, an animal shows no other sign, it can easily be returned to the yard. The tears have, in many outbreaks of rinderpest, been taken as a guide with the greatest success; and the animals separated into three lots—diseased, suspected and unsuspected. On the other hand, there have been numerous instances where no attention has been given to them, no isolation has been made, and the disease in due time appeared and caused havoc in the herd.

In the second stage of the disease, the animal appears dull, there is a loss of strength, irregular rumination and refusal of food. In milch cattle, the supply of milk diminishes. The coat stares and the animal shivers. Later on, the visible mucous membranes assume a pinkish colour; this is most perceptible at the vulva in cows, but not so in the case of buffaloes. Twitchings take place all over the body; there is a husky cough, a quick pulse and irregular breathing complicated by the muscular twitchings in such a way as to present a double expiratory movement. The animal moans or grunts from the great pain; the breath is fœtid and parts of the body become very cold as the animal becomes exhausted. The final stage is diarrhœa, the evacuations being watery and of a dirty yellowish colour, and highly offensive smell, mixed with considerable slime and some blood. These evacuations come away with great force at first, but as the animal's exhaustion increases, they trickle away involuntarily. The skin is dry, and swellings often occur about the back, loins and neck. Saliva is produced in large quantities, and an examination of the mouth shows lesions on the lips, gums and palate very similar to those which accompany foot and mouth disease. A pinkish discharge drips from the nostrils and, when eruptions appear on the skin, it may safely be assumed in nine cases out of ten that the animal will recover. In some cases, however, one side of the animal has been known to become absolutely raw from the eruptions becoming confluent. Rinderpest may appear either in a mild or severe form: if the latter, death ensues within from two to four days: but the milder form often admits of successful treatment. The disease is generally ascribed to the following causes: drought, starvation, exposure to extremes of temperature, contagion from outside cattle while at graze or on the way there and home. The carcase of any animal dying from it should be burnt, to prevent its hide being removed and sold, which is apparently the chief cause of the spread of the disease, beyond an individual herd. Carbolic acid should be used as a disinfectant, and its use should be begun and

continued whenever and as long as the disease is known to exist in the neighbourhood of any farm. All the litter and some sulphur should be burnt every morning and evening, so as to produce as much smoke as possible. Special attendants should be told off for infected cattle, and care taken that they are disinfected daily, and not allowed to approach the healthy cattle. The division of the herd into diseased, suspected and unsuspected animals should forthwith be made, and the animals should be inspected at least three times a day by an experienced man. The sheds and standings should be sluiced with a strong disinfecting solution, so that no excreta laden with the virus in a harmful condition may pass away. The standings and yard should be coated with dry quick-lime daily. In this, as in foot and mouth disease, contagion is extremely likely to occur from contact with outside cattle, and the animals of hired cartmen bringing in supplies should be rigorously kept out of a dairy yard—such carrying as has to be done being effected by a tramway and trollies. No agent has yet been discovered that will act as an effectual antidote to the rinderpest poison and inoculation cannot always be done in time to check its spread through a herd.

Treatment.

The strength of the animal must be maintained by every possible means. Linseed gruel and other nutritious and easily digestible foods should be given at frequent intervals. The linseed should be boiled with barley, flour, and a little ground pepper, in separated milk. A great deal more could be done for the repression of this disease in India than is at present being done. The authors have seen the whole of the cattle in many large villages carried away by it, and no proper measures adopted to check it. If any good is to be attained, a system of inspection must be insisted upon. The movement of cattle from infected areas must be stopped ; and when an outbreak occurs, all suspected animals should at once be segregated, and vigorous attempts made to stamp out the disease before it has time or opportunity to spread. Until the ravages of the disease are brought effectually under control, the authors must content themselves by reminding all farmers that, in the words of the old adage, prevention is better than cure. Care and strict attention to the following important matters will, they believe, avert serious loss and inconvenience, and save much anxiety of mind to the practical farmer :—

(1) Proximity of grazing grounds to the cattle-yard, enabling the cattle to go out and back without possible contact with outside cattle or their tracks ;

(2) Complete separation between the dry stock and cattle in milk ;

(3) Frequent inspection of all home cattle, and immediate isolation of animals from any disorder, however simple ; and the prompt disinfection of all ropes, standings, troughs, etc.;

(4) Perfect sanitation in and about the cattle-yard, standings, stalls, etc. ;

(5) Tramway lines for the conveyance of grain, fodder, etc., to the cattle-yard, and the rigid exclusion of all outside draught-cattle bringing in these supplies ;

(6) The allotment to sick cattle of special attendants, who must not be permitted to approach the healthy animals, or associate with the staff working in the cattle-yard ;

(7) The best and most wholesome fodder, grain, cake, etc., only fed to the cattle ; and

(8) Complete segregation at as great a distance as possible from the infected enclosure ; and, as calves are the principal medium, not more than sixteen calves should be housed together.

CHAPTER XXIII.

Establishment and Accounts.

The success of a farm depends chiefly on its working establishment, for however energetic the manager may be, he has to rely to a very great extent on his subordinate native establishment. The work is generally of so arduous a nature and

Establishment and accounts.

the exposure in all weathers so great that European supervision is not always feasible, and therefore the more a manager appreciates that he must work through his subordinates, the less likely will he be to encounter failure. Managers who consider that their own knowledge of farming is all in all, and attach no importance to the selection and employment of their subordinates, can hardly hope to obtain satisfactory results.

The following establishment is generally required on a farm :—

Working staff—
Manager.
Overseer.
Assistant Overseer (Native).
Store-keeper.
Mates.
Lambardars.
Rangers.
Cartmen or ploughmen.

Office establishment —
Clerk.
Daftri.
Peon.

Manager. A manager should possess many qualifications, and, in addition to a thorough knowledge of the vernacular of the district in which his farm is situated, he should make himself familiar with the habits and customs of the natives with whom he has to work. He ought to be just in all his dealings, absolutely straightforward, temperate and sober in his own habits. Any weaknesses or shortcomings on his part are quickly detected and taken advantage of by his subordinates, and this results in loss of respect. To the Oriental mind, the term " insaf " is one of vast significance, and a native will readily overlook other defects in his superior's character if only he is just. A manager, therefore, in addition to the actual work of the farm, must attend and listen patiently and willingly to the cares and grievances of every member of his establishment. The inclination with many, if not most, European managers is to depute this part of their work to subordinates, with the result that they lose touch with what is going on, and their men become dissatisfied. Many officials have been known to refuse to listen to the complaints of their establishment except when made through their immediate supervisor. This course must result in the suppression of many real grievances, and must prove very detrimental to farms. It is therefore incumbent on the manager to hear all grievances and settle them personally, in order to enable him to acquire a thorough knowledge of what is going on, and to detect any irregularity or dishonesty. All payments should be made either by him or in his presence, and on no account should this work be made over to a subordinate, because the natives have the greatest respect for their paymasters, and besides this the manager is assured that all payments are correctly made. For the same reason, all establishments should be personally entertained or dismissed by the manager. He should invariably treat the establishment kindly, never abusing or insulting them. Every one in authority over natives should carefully avoid these two latter weaknesses, and above all protect the female labourers from insult. Nothing lowers a European more in the eyes of a native than an insult offered to a woman.

The manager has a most difficult position to fill; his every action is carefully watched by the native establishment, and unless he strictly follows the above advice, troubles and complaints will be numerous. It is perhaps not too much to say that the success of a farm depends entirely on a manager's own moral character. Thus, if he is absolutely honest, there is very little fear of his establishment going wrong : but if, on the other hand, his actions are open to question, his establishment is sure to become careless and indifferent. In short, many who complain of bad work from their native subordinates are themselves responsible, because they have failed to follow the above instructions and have consequently lost the respect which they would otherwise have commanded. In consideration of the many failings of natives, managers should not always be quick to punish, and fines should be avoided as far as possible, unless a delinquent is drawing a moderately high salary. Always give the native establishment to understand that the hand of chastisement is raised above them ; but it should not be brought down too frequently, and whenever punishment is necessary, it should be severe.

Establishment and accounts.

The manager should exercise strict supervision over the general work of the farm, and see that all expenditure is judiciously made. He should keep a check of the outlay and income in connection with every project, so as to enable him to detect in time any that are likely to prove unprofitable. He should prevent the office and executive establishments from having any connection with each other, as when they work hand in hand, it is impossible to detect irregularities or prevent peculation. It is advisable for the office establishment to possess a knowledge of farm work in general, so as to enable them to scrutinise every item of expenditure included in the returns and reports submitted by the overseer.

Large office establishment to be avoided.

There is nothing so detrimental to the progress of a farm as a large office establishment, as the manager, instead of supervising important out-door work, is obliged to devote the best part of his day's work to the office. Strenuous efforts should therefore be made to reduce all clerical work to a minimum.

All cash accounts and important returns should be examined and initialled daily by the manager: and he should conduct his own correspondence, for, if he entrusts this to his clerks, he will be unable to control his office or know what is going on. The manager should, as far as possible, settle all local questions by personal visits and exercise the greatest tact in doing so. Even when right is on the side of the farm, it is often advisable not to push its claim. In dealing with Officers Commanding corps, and in fact with all officers, managers must always be careful not to give offence and should be invariably respectful. They will initiate no improvements without the previous sanction of the General Officer Commanding and the approval of the Director of Farms.

Overseer.

The overseer, or farm assistant, is generally selected from the garrison, and should be a man of exemplary character, sober, steady, hardworking and absolutely straightforward. He should live on the farm and be seconded from his regiment. It is preferable to secure the services of a really capable man, so that he can take charge of the farm during the manager's absence. He ought to be well paid and provided with free quarters and conveyance by the farm. It is wise policy to make all farm appointments worth having, and to enable their holders to live honestly. If the emoluments are small, peculation is frequent and hard to detect, and the employés treat the loss of their poorly-paid appointments with indifference. The overseer is the manager's right hand man and should exercise general supervision over all out-door work. He must check the time-keeper's attendance rolls, grass-cutters' registers, etc., and see that good returns are secured for the expenditure incurred. The same important matters mentioned with reference to a manager's qualifications apply to the overseer. The time-keeper will assist him in keeping the daily registers and attendance rolls, while he should himself submit daily reports of expenditure punctually to the farm office. These reports will show all expenditure in detail under the various heads. The overseer should see that all the labourers are present and check the attendance at unexpected times during the day to satisfy himself that all are at work. Very frequently, after their names have been registered in the early morning, some of the labourers, with the consent of the mate in charge, absent themselves for the rest of the day. Unexpected visits by the overseer will soon put a stop to this practice. The overseer should treat all the farm servants well, and let them see that their welfare is sought after. He should pay particular attention to the behaviour of the mates and other supervisors on this point. No *dasturi* of any kind should be allowed, and the labourers must receive their full wage: otherwise the work will suffer. One of the first duties of an overseer is to make himself thoroughly acquainted with all the labourers on the farm—men, women and children. This is an exceedingly important matter which many farm managers and overseers totally neglect, and serious loss results. If an overseer is a capable man, he should be allowed a free hand, for there is no greater discouragement to a farmer than not allowing him to use his own discretion. European assistant overseers are sometimes necessary on large farms, and are also obtained from the garrison. Their duty is to assist the overseer in any work which may be allotted to them.

Assistant native overseers.

Assistant native overseers are useful men and should be recruited from the native cavalry or from the oldest and best of the farm servants. It is important that a man elected for this appointment should be of a respectable caste and family and, if possible,

Establishment and accounts.

he should be asked to furnish the security of some rich native gentleman. Native overseers are invaluable, when the proper stamp of man is secured, as they thoroughly understand their own countrymen and also have a fair knowledge of agriculture. Men of low caste should never be selected for such appointments, as they are unable to command respect. The assistant native overseers should be employed on the general supervision of all farm work. They should be paid well and receive a progressive scale of pay according to merit.

Time-keeper.

The time-keeper's post is an important one, and care should be taken to select an honest man of good caste, so as to enable him to command respect. He should keep a register (either in Vernacular or English) of all labourers, showing in detail how they are employed, their caste, father's name and residence. He will note all absentees and bring their absence to the notice of the overseer or manager, report all slackness of work, and bring any irregularity to the notice of his superiors. No labourers should be entertained or dismissed by him, nor should he be allowed to punish labourers for neglect of duty or any other cause. Although many farm servants would be found willing to undertake the work on even Rs. 5 per mensem, the time-keeper should be well paid. A man who offers his services on so low a subsistence as Rs. 5 has evidently a double object in view. The time-keeper should receive a progressive scale of pay fixed so as to make the appointment a valuable one, and one which the holder would be reluctant to lose. The appointments of manager, overseer, native overseer, and time-keeper are what may be termed lucrative, and it is wise policy to fix the salaries moderately high. A single time-keeper is sufficient for a large farm of 5,000 acres.

Mates or native supervisors.

These should as far as possible be selected from men of good caste. Their duties are to supervise the various works in operation. They should have a thorough knowledge of the work and be able to exact a reasonable tale from the labourers. They ought to receive a progressive scale of pay, and their advancement should depend on merit. A mate must be treated as a contractor, and be held responsible that the labourers do a full day's work. He must not be permitted to entertain or dismiss any of the establishment or to interfere in any way with their wages. It is extremely difficult to prevent irregular practices on the part of these mates, and if they are allowed to oppress the labourers in any way, farm managers will always experience great trouble in commanding labour. It is therefore very important that the mates should be kept well in hand and closely watched.

A lambardar is placed in charge of a section of the farm, say about 400 acres, and is held entirely responsible for the whole of this area. He is required to prevent trespass, see to all weeding and harvesting of grass at the proper time, and make all complaints to the manager direct. Thus as far as the work is concerned, these men will have, practically speaking, a free hand, which is an inducement to them to work well. As many rangers as are considered necessary for the protection of each section should be placed under the lambardar. These rangers work under his orders, and he is responsible for their work to the overseer or manager. Except when their work is unsatisfactory, lambardars should not be transferred. Their emoluments should be regulated so as to command the services of good men and to encourage honest work. The agricultural classes are best suited for these appointments, and it is perhaps advisable to obtain them from the Hindu castes, care being taken to avoid the employment of low caste men. The plan of placing the rangers or chowkidars under the care of the lambardar has prevented many dishonest practices on the part of rangers, which it would have been impossible otherwise to detect. It is in fact applying the old maxim of setting a thief to catch a thief. To prevent a lambardar from soiling his hands with illicit receipts, he is given, as a start-off, a salary equal to about three times that of a ranger.

Rangers, or chaukidars.

It is exceedingly difficult to secure honest rangers, as the work is of such a nature and the temptations are so numerous, that a man with even the very best intentions often gives way. Rangers are employed to protect the land, to prevent cattle-trespass and thefts of grass, and to stop pathways being made across farm lands. To show how lucrative these posts are, the following instance may be quoted. A ranger's post on Rs. 4 per mensem was vacant on a certain farm and candidates were advertised for. One of the conditions of employment was that the successful candidate should deposit Rs. 300 as security. No less than 200 candidates applied for the post,

a fact which illustrates to what extent dishonesty must be carried on by rangers. The owner of cattle starts by introducing the ranger to his banker or bania who lends him money and provides him with grain on the cattle-owner's security. If the ranger resists this temptation, he is then tempted with milk and *dahi*, and he is carefully attended to by the cattle-owners when sick or indisposed. The final temptation is on religious grounds. He is termed a "Hattia," because, being a Hindu, he refuses a cow its food. Cattle-owners fully appreciate the value of good grazing, and are prepared to offer almost any bribe for their animals to be allowed to graze. Some owners have been fined as much as Rs. 200 in a year, and still persist in illicit grazing. If, on the other hand, a ranger will not allow illicit grazing and impounds cattle found trespassing, false reports regarding him will be numerous, and the farm manager must himself carefully investigate them. The ranger has perhaps the most difficult duties to perform and, sooner or later, the best of them yield to the many temptations placed in their way. It may be impossible to entirely stop dishonest practices on the part of the men, but regular and frequent inspection of their work at unexpected hours, both night and day, and occasional transfer from one section to another, will reduce these to a minimum. They should be well paid and should be severely punished when caught tripping. Rangers have been known to make as much as Rs. 40 in a single day by permitting illicit grazing. Every effort should therefore be made by the manager and his assistants to exercise that check over the work of rangers which will secure the best results.

Cartmen and ploughmen.

These must be recruited from the agricultural classes. No chamars or low caste men should be employed, except when the farm contracts for the removal of rubbish or night soil. When work of this nature has to be done, natives of other castes will refuse to do it, so that it is advisable to entertain a few low caste men for the purpose. The best classes are *Ahirs, Thakurs, Khatris, Kachis, Gujars, Jats*, and *Rajputs*. The *pasi* or swine-keeper class should not be employed as cartmen or ploughmen, for *pasis*, like *chamars* and other low caste natives, have no love for cattle, and therefore have no scruples about robbing the animal's food. The better classes take more care of their animals, have a greater regard for them, and will seldom or ever be found guilty of such cruelty. When not ploughing or driving carts, this establishment can be employed on any other farm work. Ploughmen and cartmen should be paid well in order to secure really good men and good work.

In addition to the above establishment, beldars, grass-cutters, coolies, children carpenters, blacksmiths, etc., are generally employed on all farms, as occasion requires No useful hints can be given regarding them as the conditions vary so much all over India, and managers must use their own discretion as to the best means for securing good work from them.

Advice to farm managers.

The following advice regarding the management of the working classes may, however, prove helpful. Natives require to be humoured like little children and if managed with tact, can be induced to do any work, however arduous it may be. Some European managers loathe even the appearance of these poor unfortunates and curse the day they ever had anything to do with them. They compel them to work often against their will, and refuse to listen to their complaints. Farm managers should remember that the sooner they become acquainted with the habits and customs of the natives and sympathise with them, the better. They should bear in mind that natives cannot be driven to work and their religious prejudices should always be studied and rigidly respected. Mere persuasion and what the native terms *mita golis* (sweet words) will induce them to do anything required of them. The manager should see that they are paid regularly in full, that they are subjected to no oppression of any sort by any of the farm supervisors, that they are allowed their usual holidays, and, in fact, should do his best to prove to them that he is their "Ma Bap" or "Garib Parwar." If he is guided by these hints, success will be certain.

The hints given above in regard to the entertainment and management of farm establishments may by many be considered insignificant, but the authors have witnessed so many failures from neglect in attending to them, that they feel compelled not only to mention them, but to impress them strongly on all farm managers and to emphasize their importance in the successful working of a farm.

Establishment and accounts.

Office and accounts.

Although it has been previously stated that a farm manager should devote as little of his time as possible to office work, it is nevertheless equally essential that he should be a capable office manager, and see that all correspondence is conducted correctly and kept up to date, that the cash book and all other important documents are carefully kept up, and that all cash realisations are credited regularly into the Bank. All correspondence and farm records should be carefully filed by the file system, and the manager should pay particular attention to preventing the executive establishment from entering the office. Without his previous sanction no contractor should be permitted to enter the office.

Monthly accounts.

The following accounts and returns are submitted monthly to the Examiner of Supply and Transport Accounts:—

(1) Statement showing cheques drawn on Civil Treasuries during the month.

(2) Statement showing the actual cash in hand on the last day of each month. No balance should ever be retained, as all disbursements should be made before the end of the month.

(3) A copy of the farm cash book, showing all transactions either by cash or by cheque. This should be a complete and accurate detailed record of all daily transactions, both of receipts and expenditure, for the month.

(4) Permanent establishment pay bill, showing the names and appointments of all employés.

(5) The monthly expenditure return should be regarded as the most important of all the farm accounts. It shows the expenditure under the various heads in detail, and is prepared from the manager's or overseer's daily reports of expenditure. As "the cost of production" is worked out in it, this form shows at a glance which projects are profitable or otherwise. Care should be taken that all necessary receipts and vouchers accompany this account when it is submitted to the Examiner.

(6) The inefficient balance statement shows all advances of money made during the month or remaining unadjusted. The entries in the schedule should be strictly confined to—

(*a*) The balance of the previous month's unadjusted advances;

(*b*) Increases arising from advances for military farm services made during any one month which have not been adjusted within the month;

(*c*) Decreases caused by the adjustment during the month of any portion of a previous month's advances; and

(*d*) Balances of all advances outstanding at the end of the month.

(7) Roll of farm animals.

(8) The Store return (with vouchers). All receipts and issues, and all transactions of fodder and grain must be recorded in this.

(9) Objection statements; and

(10) A dead-stock return is submitted at the close of each financial year, verification reports being sent in periodically to admit of its check.

Annual accounts.

The budget estimate should be submitted annually by the 1st August to the Director of Farms, and the annual report should reach that officer by the 15th September.

The preparation of these returns is, after all, a very simple matter, and any farm manager of ordinary intelligence can, in a very short time, master the work.

Method of check.

It has been frequently urged that an effective check cannot be exercised over farm expenditure, as it is impossible to detect peculation: but the experienced manager will find no difficulty in applying all the necessary checks and putting a stop to peculation. With an inexperienced manager, of course, dishonest practices would escape detection. The accounts and returns prepared and submitted to him by the overseer and other subordinate executive establishments form the basis of all farm accounts, and if he applies the requisite check to these, his accounts must be correct.

Establishment and accounts.

Overseer's reports.

The following accounts are prepared and submitted by the farm overseer to the office, either daily or monthly :—

(1) Daily report of expenditure.
(2) „ register of labourers.
(3) „ register of grass-cutters.
(4) Outturn and disposal of grass.
(5) Daily receipts and issues of grass.
(6) Vernacular lease parchments.
(7) Vernacular grazing parchments.
(8) Yearly progress report.

Preparation of daily report of expenditure.

The daily report of expenditure is similar to the contingent return, and both follow the lines on which the budget estimate is prepared. The overseer prepares it from the time-keeper's books in which ought to be shown the various labourers employed on each work or class of work in hand. The time-keeper may keep his register either in Vernacular or in English : but the overseer's daily report should tally with it in respect of every entry. Everything depends wholly on the correct and prompt submission of reports of expenditure, honestly and judiciously incurred, and, so long as these reports are seen by him daily, a farm manager is in a position to see at once whether charges are correctly made, or whether expenditure is being unnecessarily incurred. If not submitted on the day to which they pertain, these reports should reach his office not later than the following day. Prior to the introduction of these reports, all labourers were shown together and their wages charged in lump. No check on the expenditure for the various operations being carried out was, therefore, possible ; but now that the labourers are shown separately for each work, the manager can readily check every item. As a further safeguard. the manager, in his daily rounds, can note the number of labourers employed at one or more of the works in progress and thus personally verify the numbers shown in the daily report. It is, however, always advisable to compare the daily report with the time-keeper's register ; the time-keeper should not be allowed to use slips of paper or even a note book for the number of labourers employed, but should be compelled to make every entry direct in his register.

All expenditure included in the daily report.

All expenditure should be entered in the daily report, and in it should also be shown the quantity and weight of grass cut, and whether the grass was disposed of green, siloed, or converted into hay. This will enable the manager to check the quantities as issued. The quantity can be checked by the daily issue register, or if siloed, or turned into hay, the quantities can be easily determined by allowing $1\frac{1}{2}$ maunds of green grass to every maund of silage and $2\frac{1}{2}$ maunds for every maund of hay. If the daily report of expenditure is carefully and regularly scrutinised, peculation is rendered practically impossible. It may indeed be said with certainty that successful farming is largely dependent upon a rigid check of expenditure.

Daily register of labourers.

The daily register of labourers is kept by the time-keeper. It should show name, father's name, caste and residence of all labourers. In it the time-keeper should daily record the names of all absentees, and it should be initialled daily either by the manager or the overseer. It is the basis of all payments to labourers, whether they are paid daily, weekly or fortnightly. Where the cowrie or shell system is followed, no register is necessary, as the labourers are paid on the spot by shells. A manager should always endeavour to employ the same labourers regularly, and should try and make himself familiar with their names, etc. This is a point of some importance, as it enables him to detect irregularities on the time-keeper's part. It is difficult to describe all the tricks of a time-keeper, but an energetic manager will soon discover them, and, by careful supervision, can easily circumvent him.

The daily register of grass-cutters.

The register of grass-cutters is generally kept up by the overseer and assistant overseers. The name of every grass-cutter employed should be entered, and not, as is sometimes done, the number of members of the same family grouped under one name. If each grass-cutter's name is registered, it is easy to arrive at an approximate estimate of the grass cut, from the average quantity of grass that can be cut in a day. When the names are not registered separately, and a whole family is entered under the name of one of its members, with the total quantity of grass cut by the

family against it, it is impossible to check the exact quantity cut. In a case of this kind, when the subordinate in charge was questioned as to the possibility of one individual being able to cut so large a quantity in a day, his reply was that there were several others assisting: of course, the intention was a dishonest one, the overseer or subordinate in charge having arranged for the recovery of the extra payment made for the grass from the grass-cutters at their houses or away from the farm. This irregularity is, however, not feasible when individual names are registered, as the manager, with his knowledge of a grass-cutter's capabilities, would be at once able to detect it. The manager ought himself occasionally to weigh all the grass cut, and record the grass-cutters' names—so as to ascertain with a greater degree of accuracy what quantity of grass to expect from each grass-cutter. Registers should always be maintained, even when cash payments are made each day for the quantity of grass cut. This will enable the manager to calculate the daily wage of each grass-cutter. As in the case of the labourers, the name, father's name, caste and village, of the grass-cutters should be recorded.

Various systems have been tried in the harvesting of grass with a view to economise labour and time, but no system has been found to answer so well, and none other than that above described should be permitted. Some advocate the ticket system, for which much saving of time and trouble are claimed. The overseer or assistant overseer gives each labourer a piece of paper with the quantity of the grass cut noted thereon, while the counterfoil is retained by the former. At the time of payment, which may be daily, weekly, or otherwise, these tickets are produced and payment made on them. There are many drawbacks to such a system, and the advantages claimed for it do not really exist, and do not warrant its introduction.

Where grass is weighed, the register system must always be applied, and no other. After a farm has been established for some time, grass-cutters will always need to be entertained, and the manager will himself soon become acquainted with their names—a fact which will assist him greatly in applying the necessary check.

Statement of outturn of grass.

The statement showing the outturn of grass and its disposal is most useful, and if properly kept up, it will enable a manager to distinguish between his superior and inferior grass lands and show him which are paying and which not. A copy of this statement is furnished below:—

Account of grass cut off different localities, and how disposed of, for the month of_____190 .

हिसाब घास जो कि मुख़तलिफ़ जगहों से काटी गई और किस तरह ख़र्च हुई बाबत् महीने _____ सन १९० .

							DISPOSAL OF GRASS CUT. घास किस तरह पर ख़र्च हुई।					
Date. तारीख़	Quantity of grass cut. तादाद कटी घास Mds. S.	Rate. निरख़	Amount. जमा	Name of plot from which cut and area. जगह का नाम जहां से घास काटी गई सीर	By whom cut. नाम काटने वालों का	Green grass for hay. हरी घास सुखाई गई Mds. S.	Green grass siloed. हरी घास खत्ते में डाली गई Mds. S.	Green grass issued. हरी घास रासन में दीगई Mds. S.	Green grass sold. हरी घास बिक गई Mds. S.	Loss. नुक़सान हुई Mds. S.	Remarks. कैफ़ियत
	मन सेर		Rs. a. p.			मन सेर	मन सेर	मन सेर	मन सेर	मन सेर	
Total in maunds मौजान											

The 190 .

Overseer of the Farm.

Establishment and accounts.

It will be seen that this statement shows the quantity of grass cut daily, the rate paid, the name of the plot from which the grass was cut and how it was cut, whether (*a*) by daily labour, (*b*) by piece work, (*c*) by weight, or (*d*) by cavalry grass-cutters. The disposal column shows the grass made into hay, siloed or issued as green grass, the green grass sold, and the loss by dryage, etc. This enables a manager to detect any frauds with the greatest of ease.

Check on silo pits and grass issues.

It is advisable when filling silo pits to depute one assistant overseer specially for the weighment of the grass, so that in case of any deficiency he can be held responsible. Natives naturally object to this and are full of excuses to secure the help of others so as to defy the manager in any attempt to blame an individual. Similarly, with green grass for issue direct—one man should be deputed for this special work. He should be furnished with a similar form daily, and the quantity cut under his supervision should tally with the ration return or indent received from the corps to which it was issued. Here, also, no man is willing to undertake the work alone for similar reasons.

Supervision o harvesting operations.

A responsible man should also be deputed to weigh all grass intended for conversion into hay, and in the case of grass cut by cavalry grass-cutters, a separate supervisor is necessary, In fact, no farm assistant should ever be permitted to weigh and register the grass cut for more than one particular purpose. If the same man is deputed to weigh grass cut for hay by hired labour and by the cavalry grass-cutters, he could, without detection, reduce the quantity cut by the latter by increasing that cut by the former, and thus be able to charge for the excess quantity cut free by the cavalry grass-cutters.

It is very essential to furnish a detail of the disposal of grass cut daily, for this will enable the manager to check any dishonesty that may take place. Supposing an assistant overseer showed 300 maunds of grass cut for hay on any particular day, when only 100 maunds were actually cut, the manager, by checking the number of hay-cocks made from the day's grass, would discover the fraud at once. He would calculate the outturn of hay expected from 300 maunds of green grass, by allowing 2 maunds of green grass to 1 maund of hay, or in any fair proportion according to the time of the year, which can easily be ascertained by experience.

This statement should be in both English and Vernacular, as it is used by both European and native subordinates. At the end of each month the overseer signs and submits it to the farm office.

Daily receipts and issues of grass.

The abstract of daily issues of fodder is also a very helpful statement of account and the monthly store return is prepared from it. The following is a copy of it :—

Farm Form No.

Monthly Abstract of Iss ____ *190*__.

माहवारी खुलासा ____ .

Date. तारीख़	Transport Animals. ट्रान्सपोर्ट										Battle. बैटरी नवर										Remarks. कैफ़ियत	Date. तारीख़
	Green Grass. हरी घास		Hay. हे सूखी घास		Silage. खत्ते की घास		Khirbi. करबी		Other Fodder.		Green Grass. हरी घास		Hay. हे सूखी घास		Silage.		Khirbi.		Other Crops.			
	मन Mds.	सेर S.	मन Mds.	सेर S.	मन Mds.	सेर S.	मन Mds.	सेर S.	मन Mds.	सेर S.	मन Mds.	सेर S.	मन Mds.	सेर S.								
1 १																						1 १
2 २																						2 २
3 ३																						3 ३
4 ४																						4 ४
5 ५																						5 ५
6 ६																						6 ६
7 ७																						7 ७
8 ८																						8 ८
9 ९																						9 ९
10 १०																						10 १०
11 ११																						11 ११
12 १२																						12 १२
13 १३																						13 १३
14 १४																						14 १४
15 १५																						15 १५
16 १६																						16 १६
17 १७																						17 १७
18 १८																						18 १८
19 १९																						19 १९
20 २०																						20 २०
21 २१																						21 २१
22 २२																						22 २२
23 २३																						23 २३
24 २४																						24 २४
25 २५																						25 २५
26 २६																						26 २६
27 २७																						27 २७
28 २८																						28 २८
29 २९																						29 २९
30 ३०																						30 ३०
31 ३१																						31 ३१
Total मीज़ान																						

Establishment and accounts.

It will be seen that it shows all issues in detail, and is submitted at the end of each month to the office. If one or more men are engaged in issuing grass, each should maintain one of these forms, and in the column of remarks the signature of the parties drawing grass should be taken.

The progress report should be submitted to the office monthly by the overseer in the form which is given. This is one of the most important returns, and shows at a glance the financial results of all improvements. Progress report.

PROGRESS STATEMENT.

Station.	Supply of Manure.			Cost of Manuring per Annum.											Area Manured.			Outturn in green Grass.			Remarks.
	Source of supply.	Description of manure.	Quantity in cart loads.	Manure.			Cartage.			Labour.			Total.			Top-dressed.	Rubbish trenched.	Night-soil trenched.	Top-dressing.	Rubbish trenching.	Night-soil trenching.	
				Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.							

It will be observed that it furnishes information as to the areas manured under the various methods, the total expenditure incurred and the outturn of grass obtained. This statement is absolutely necessary, and the areas manured and system followed should be carefully marked on the farm map, as this information enables a manager to see whether his farm is paying or not, and so prevents him from incurring needless expenditure. It also serves as a guide to his successor. In no other account are the financial position of a farm and the extent of work done so clearly exhibited. In this respect, the profits shown by the Military Accounts Department are an altogether uncertain test, as owing to the variation in the market value of produce, it is impossible to determine which farm has made the most progress. Production rates, too, are equally unsafe as a guide, but farm managers can with confidence accept the progress report as the best test by which to judge the work done by their subordinates during the year. It should be attached to the annual reports.

Vernacular parchments.

Wherever land is sublet to tenants for cultivation or grazing, vernacular parchment leases are necessary. They should be prepared in duplicate, one copy signed by the manager being given to the lessee, and the other signed by the lessee being retained in the farm office.

Many other hints might be recorded, but these can be gained easily by managers from daily practice. Managers and overseers should always carry a pocket book with them, for the absence of one denotes carelessness or indifference. Every fresh experience should be immediately noted, and any other matter of importance in connection with farm work.

In conclusion, the authors would impress upon all farm managers what has been chiefly instrumental in their own successful farming—simple, whole-hearted devotion to work, and strict supervision over all expenditure, which prevented peculation and ensured judicious and honest expenditure.

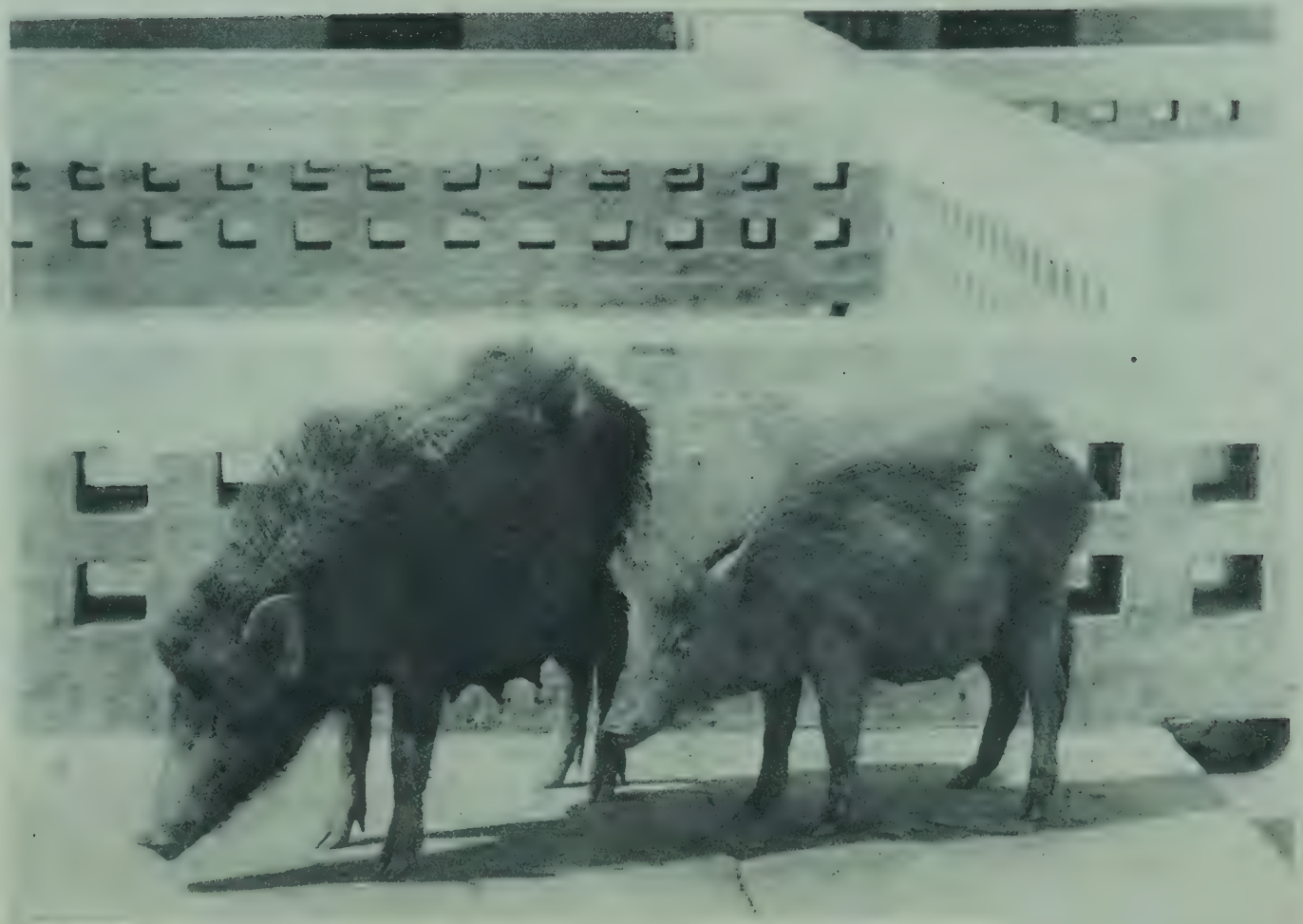


Photo-zincotype Survey of India Offices, Calcutta, March, 1903

The common country pig. The one on the left is 2½ years old, and the other 18 months old.

THE FARM MANUAL.

PART II.

THE PIG AND ITS PRODUCTS.

CHAPTER I.

Breeding of Pigs.

India, as a bacon-curing country.

There is, perhaps, no country in the world where the bacon-curing industry is more capable of development, or where improvement is more urgently called for, than India, and any effort in this direction would undoubtedly be amply recompensed.

The bacon-curing industry.

In almost all countries in Europe, great attention is being paid to the development of this industry, and rapid strides are being made everywhere. India, as a bacon-curing country, occupies really no position at all, or a very inferior one, although its natural conditions are suitable to the pig, and the necessary food is plentiful and cheap. If good and wholesome bacon and ham were manufactured more cheaply in the country, the necessity for their importation would cease. Experiments already made show that, with refrigerating plant, excellent bacon can be manufactured without difficulty during the summer months in the hills and in the winter on the plains, when the climate is fairly adapted to the process; and this being the case, there is no reason why India should not produce bacon of as good quality as is obtainable from Europe—the mere details of the curing process being the property of neither country nor individual.

The Indian pig.

It may be taken as a postulate that no animal contributes more directly to the support of the people, and is so little understood by them, as the pig in India. Indeed, the pig is more spurned and despised here than elsewhere: a fact which is probably due to the ill-shape, coarseness and natural filthiness of the indigenous pig, and the insanitary way in which it is kept.

Piggeries as adjuncts of dairies.

With the establishment of Dairy Farms in India, the need for piggeries as an adjunct has forced itself, more or less keenly, into notice: as, without them, large quantities of separated and butter milk go to waste. The advantages of such an adjunct to a dairy are many: and the close association between dairying and bacon-curing is an economic point worthy of consideration. Denmark, where the bye-products of the dairies are fed to the pigs with excellent results, affords convincing testimony to the intimate relation of the two industries.

Importation of English stock for breeding.

Success cannot be attained in India, until a very marked improvement is made in the quality of the country-bred pig. This might easily be effected by the importation by Government of well-bred English boars for free distribution all over the country with a view to encourage pig-breeding—by crossing, in the first instance, well shaped country sows with these English boars. Any well-considered step in this direction would certainly produce good results, but the initiative must rest with Government. Intelligent direction in the breeding of the pig has produced the results obtained in Europe and elsewhere, and the enormous improvements effected in Great Britain alone demonstrate how great such improvement can be. If, with

Breeding of pigs.

suitable modifications, the same principles were followed, equally successful results may reasonably be expected in India.

The advantages of pig-breeding in India.

As a food-producing animal, there is none more beneficial to mankind than the pig. Its flesh is substantial and delicious: it is a favourite dish, either fresh or salted with a very small exception, the whole of its offal is fit for human consumption: it bristles are used for brushes, and its skin for leather. In its fresh state, many natives of India partake of large quantities of it, even in ordinary times; while during the recent famine pigs have served as a means of support during the times of greatest stress. Many of the lower castes eat pork regularly,—not only because it is cheaper, but from preference. The famine made pigs scarce everywhere, and, even now, they are scarce in many districts where they were formerly met with in abundance. These facts point to the importance of pigs as a stand-by in times of drought and distress in India, and raise the question whether it would not be worth while to improve and extend the pig-breeding industry, not only as regards bacon-curing for the European but in the interests of the native population in general.

Comparison of country pigs with imported stock.

A comparison of the country pig with the improved varieties obtained from such crosses with imported English stock as have been referred to above will illustrate the wonderful influence which judicious selection of parents and careful domestication exercise in changing the natural characteristics of animals. Plate 1 shows two common country sows, 18 months old. Observe the flat sides, long legs, long snouts and abundance of hair and bristles. Plate 2 shows a country boar at 14 months old which was being used for breeding at the time the photograph was taken. It shows how little the native of India cares about the principles of breeding, while the inferior stock produced by such a boar can well be imagined. Larger boars are, of course, used by *khatiks* who have more experience in breeding. The greatest fault in the common Indian pig is the positive coarseness of its form, which retards maturity. In some parts of India, in the hills especially, the country pig is a very different animal to those shown in plate 2 which represents the pig of Northern India.

How to improve Indian breeds.

Cleanliness, regular feeding, and constant attention to breeding only from animals of healthy constitution and improved form, have been mainly conducive to the good results achieved in other countries, and there can be no doubt that they would operate with equally good effect in the improvement of the Indian pig. Many individual attempts have been made from time to time to improve the indigenous breeds by crossing with imported or foreign stock, but from various causes they have not been steadily followed up, and in many cases failed for want of knowledge of the first principles of breeding.

Breeding.

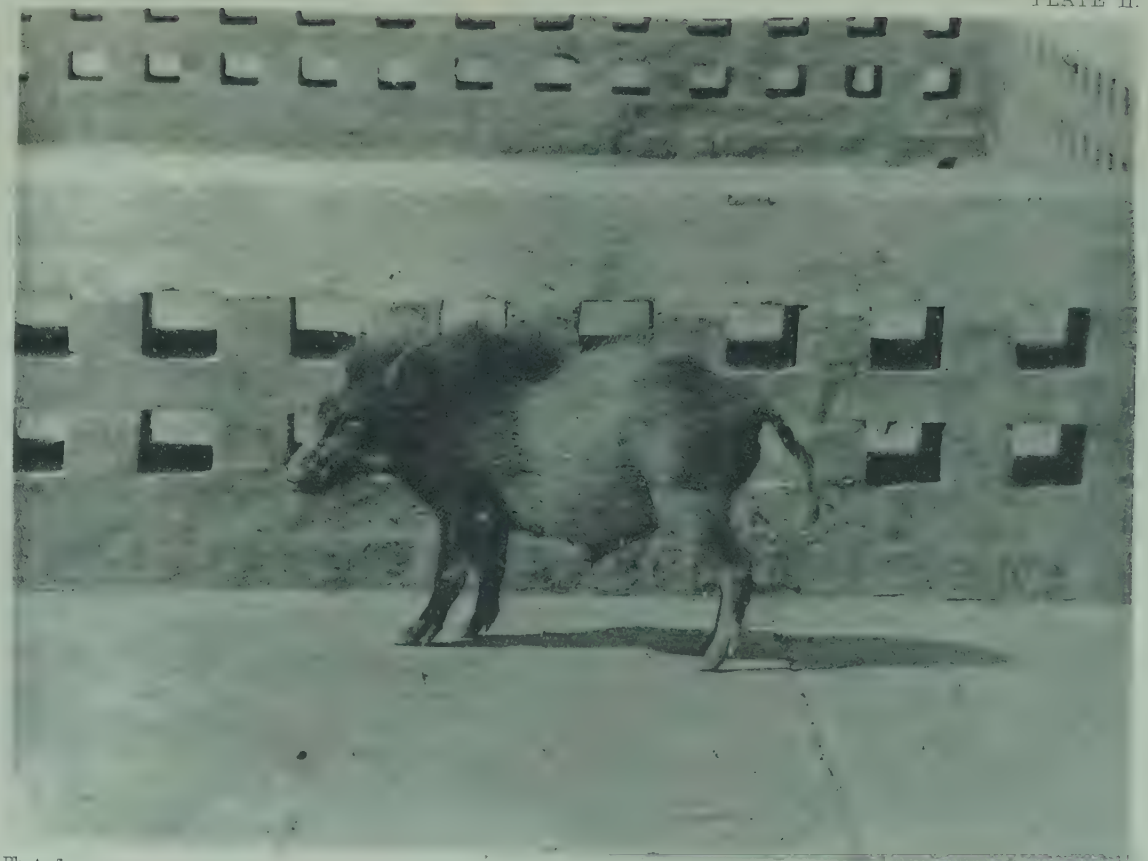
Breeding may be truly described as an art. Its basis is the skilful selection of the males and females for the purpose in view, with careful regard to their merits and defects. With intelligent care in this matter, combined with sound judgment and constant observation, success is almost certain. Breeding demands great patience, discrimination and sound judgment; judgment in breeding can only be acquired by experience, and intelligence in selection by constant practice. Much, too, depends upon the intelligent selection of parents. Where the above precautions have been strictly attended to, instances of successful breeding have been numerous, and failure has only followed their neglect.

The part selection plays in breeding.

The influence which selection has on the quality of animals, and the power it exercises in perpetuating good and bad qualities in the offspring are extremely important points in breeding. It must be admitted, and the admission is one that can only be made with extreme regret, that in no other country in the world do these truths require to be more forcibly insisted upon than in India. No improvement in the breed of the country pig can be brought about except by careful selection of the parents, and the selection should be so made as to secure stock of early maturity and rapid fattening qualities, though perfection may, and probably will, not be attained until after three or even four crossings. In the selection of animals, close, (or in-and-in), breeding should be carefully avoided.

In-and-in breeding.

Some breeders advocate close-breeding, but experience has shown that it is better to avoid it, as it leads to diminutive progeny (one of the principal signs of



Photogravure.

Survey of India Offices, Calcutta, March 1903

A country boar, 14 months old, already used for breeding.

Photo-engraved at the Survey of Israel Office, Cairo, Egypt, March, 1903

A 2-year old sow, by Berkshire boar and cross-bred sow. The original stock was produced by Berkshire boar and country sow.

Breeding of pigs.

deterioration), delicate in constitution and slow in fattening, while in the case of sows, the litters are small and the mothers bad sucklers.

When pigs come to maturity.

It takes fully two years for the country pig to attain maturity and the offspring of country sows by imported English boars have also been found to be slow growers, not attaining maturity till about 18 months old, whereas English stock is ready for bacon at from 8 to 10 months, after which they put on fat so rapidly as to be fit only for sausages.

Cross-breeding.

The offspring of the first cross are generally small and resemble the mother. They are leggy; their skins are a little finer than their dam's, though coarse; the sides and ribs are not nearly so flat as her's; the hair is finer though coarse: and the bristles are long and abundant. Their backs are straighter than the mother's—though the arch is noticeable, and the heads are long and narrow and the snouts very pointed. It is regretted that illustrations cannot be given of a first cross between the country and imported pig: but plate 3 shows a two-year old sow out of a cross-bred dam (a country sow and a Berkshire boar) by a Berkshire boar. Having once secured half-bred sows out of a country sow by an English boar, only these sows should be crossed thereafter: the mothers being fattened and slaughtered. Every endeavour should be made in this way to breed up until the desired quality of animal has been obtained.

Cross-bred boars should not be used for breeding purposes.

As it will always be necessary to preserve the improved race, only pure-bred pigs should be retained. Cross-bred boars should not be used for breeding purposes unless thay have some special qualities which it is desired to perpetuate; and when used, they should have no admixture of Indian blood in their veins, or the offspring will inevitably deteriorate.

Points to be observed.

The principal points to be observed in pigs used for breeding purposes are—

(*a*) that the sows are prolific and good sucklers;

(*b*) that the litters are even in size and keep in good condition, while growing; and

(*c*) that the animals, while fattening, are firm of flesh, and, when killed, their meat streaky, and the bone fine and proportionately small.

Imported pigs experimented on.

The pigs experimented with at Allahabad are (1) the Berkshire, (2) large-white, (3) mid-white, (4) small-white, and (5) the China; and all have done much to improve the stock.

Characteristics of the Berkshire pig.

The characteristics of the Berkshire breed are:—The colour is black, with a little white on the face, as well as on the four feet below the knees, but not too high up; and there is also a little white at the tip of the tail. The marking should, as far as possible, be regular on all the feet. (The presence of white elsewhere on the body, although compatible with purity of blood, is regarded as a disqualification at shows or prize-meetings.) The head should be short, and the nose slightly turned up, although many pigs have straight snouts; the ears should be erect, but may occasionally have a slight droop; the jowls, or jaws, should be full, and the neck full, short and thick; the back should be straight, very broad and thick. (Some pigs of this breed have slightly arched backs.) The ribs are long and give a rotundity of body; the sides are deep; the hind parts are always fully developed, the hips are long, the hams deep and well-rounded, the tail fine and well set high, the legs short and fine in bone: the hair generally curly and abundant, but fine. The boar shown in plate 4 was imported from England from Sanders Spencer of Holywell St. Ives. Sanders Spencer is a well-known breeder of pigs, and exports them largely to many countries. "Lord Ormond" is a "pedigree" pig, and was landed in India when only three months old. He is now about six years of age, and is no longer used for producing stock. He has stood the climate very well, and has been worth his weight in gold for the improvement, for which he alone is responsible, in the breeding of pigs at Allahabad, which has made rapid strides from 1891 to the present time. The Berkshire boar is the best for crossing purposes, and has the power of propagating its qualities speedily to its progeny, its principal characteristics being the ability to lay on flesh of excellent quality with a fairly large proportion of lean to carcase weight. This is illustrated in the crosses between the country pigs and small and mid-whites, which will be referred to later on. It is a hardy animal, prolific, and seems to stand the

Indian climate better than any other class of English pig — an important point to remember when importing pigs for use in this country. In short, the Berkshire pig's great muscular power renders it less liable to disease than other breeds. It is active, and its litters are always healthy and fatten quickly.

The large-white or Yorkshire pig.

For a specimen of the large-whites, reference is invited to plate No. 5, reproduced from a photograph of "Lady Weston"—a sow imported when she was only two months old. This breed grows somewhat slowly and does not reach maturity so rapidly as the Berkshire. The head is moderately long : the ears are long and pendulous : the face is rather narrow and there is no hollow between the eyes. The back is level, the sides are deep and the legs small. The hair is somewhat plentiful, long, and straight. These pigs lay on meat in which there is a fair proportion of lean. The sows give larger litters, but they are not always found to be good mothers, as is the case with "Lady Weston" and many of her offspring. They do not seem to stand the climate of India so well as the Berkshire pig, and this may perhaps account for their being such indifferent mothers. The boars too have not produced such good results as the Berkshire or mid-whites, as they become too large and are generally inactive.

Mid-whites.

For the mid-white breed, see plates 6, 7, 8 and 9. This breed also has been found very useful in India. It is good for crossing purposes and is more profitable than the large-whites. The animal is more compact and arrives at maturity earlier than the large-white and its disposition to lay on fat is more marked. The head is short and the snout turns up, forming a saucer face. There is a good width between the eyes ; the ears are almost erect, the jaws are heavy and the neck full. The back is wide and should ordinarily be level, though it is often slightly arched. The tail is curled and set on high; the hams are full and the shoulders fine. The legs are, as a rule, short, the bone fine, and the hair abundant with an inclination sometimes to curl.

Very fat bacon not desired.

This breed is apt to lay on too great a proportion of fat—and if fat bacon is not appreciated in England, it is less so in India. When pigs of this breed were fed on separated milk and corn, for ten months, their flesh was found too fat for bacon and customers frequently complained of the undue proportion of fat. Every effort should, therefore, be directed towards producing animals suited for the purpose intended—*i.e.*, to obtain animals that will mature and fatten quickly, and will yield meat with a well-balanced proportion of fat to lean.

Cross-breeds, (Berkshire and Yorkshire) produce lean pork.

Plates Nos. 10 and 11 show crosses between the Berkshire boar and mid-white. These crosses have turned out excellent pigs for bacon, their flesh being superior and consisting of a large and well-distributed proportion of lean. Even the thoroughbred Berkshire pigs have often been found too fat for bacon, whereas the crosses have left nothing to be desired. This cross is largely bred on the Allahabad Farm at present.

How to produce lean meat.

It may be argued that the production of leanness in pork is due to systematic and judicious feeding, and this argument is to a certain extent logical. But these cross-bred pigs were fattened with other pure breeds and received the same food. Yet, while the flesh of the pure breeds consisted of too much fat, that of the cross-breeds contained more lean and was superior in every respect. The cross-breeds are also hardier of constitution, mature earlier, fatten more quickly and grow to larger weight than the pure breeds. These considerations justify their breeding in India, both for pork and bacon.

Small-whites.

The small-white breed is not so suitable as the breeds already named, and many experiments have shown it inexpedient to continue their breeding.

China pigs.

A specimen of the China pig is given in plate 12, and in the same plate is shown her litter, four weeks old, by a Berkshire boar. Although this sow was imported direct from China, she is by no means a good specimen. China pigs mature early and fatten with rapidity, but they are not very weighty. Their legs are small, (so small indeed that the belly of a sow when in young touches the ground); they have fine bones and are not very round in body. The head is short and thick, the eyes are almost hidden from view, the jowls are full, the ears small and erect, and the hair abundant and fine. The sows are prolific, and are good nurses and sucklers. The offspring produced by crossing with English boars is simply all that could be desired.

Photogravure

Survey of India Offices, [illegible]

"Lord Ormond," a pedigree Berrkshire boar, 6 years old.

Photogravure.

Survey of India Offices, Calcutta, March, 1903.

"Lady Weston," a large white sow, 5 years old, imported from England when 3 months old.

Breeding of pigs.

They are healthy, good feeders and grazers, and mature and fatten much quicker than other crosses. Their flesh is the best ever produced on the Allahabad Farm, containing the largest proportion of lean to carcase-weight found in any breed. For a cross between a China sow and an English mid-white boar ("Prince Victor") see plate 13; the litter represented is only four months old. In plate 14 will be seen two hogs, six months old, being fattened for bacon. The mother of these litters is very small while the boars were very large, and the litters are as level as possible. For pork, the white pig has been found to answer best as it is more easily cleaned. Even in bacon-curing, the rind of the black is seldom or ever as clean as that of the white variety.

Crosses with the China pig.

In order to attain success in pig-keeping, the following points must always be carefully borne in mind: breeding, general management, and feeding in such a way as to produce pigs that will feed well, fatten quickly, attain maturity early and develop an abundance of lean flesh.

Successful pig-keeping dependent on breeding, general management and feeding.

Great care is necessary in the management and selection of a boar; but in a large breeding establishment, the tendency is to allow any and every boar to mate as he pleases. This irregular and grossly careless management must sooner or later result in serious failure, and can only happen with those who have no idea whatever of the principles of breeding.

Management of the boar.

The Berkshire boar is the best for India, as in addition to his other qualities, he is able to stand the climate better than other breeds. The mid-white has also done well, but cannot stand the climate so well. It is, however, advisable to keep both these breeds.

Breeds best suited for India.

With a view to breeding, boars should in the first instance be imported direct from England, and only pedigree stock should be selected. "Show" animals should not be purchased as they are always very high-priced; but at the same time, it must be remembered that it is not every boar that will suit—although on grounds of economy such a course is frequently adopted with results which any breeder can easily imagine. See plate 15 of "Fraud" a boar imported a year ago as a mid-white boar. His bad points are not all very conspicuous in the plate, but it can be said with certainty that he has hardly a single point in his favour. "Lord Ormond" was imported and landed in India at a cost of £14, whereas "Fraud" cost £12, and the former was of known pedigree. The facts show that only pedigree animals can be relied on.

Importation of boars for breeding.

It is safer to use thorough-bred boars from good stock for breeding, as the necessity for pedigree may be regarded as of primary importance. The next consideration in the selection of a boar is the relation and size of the sire and dam. A medium sized boar, perfect in all its parts, is more serviceable than a large or small one. It should be of a strong masculine character with fine external form, the hair abundant and long but not coarse. An abundance of fine hair indicates lean meat as in the case of the country pig, the hair of which is very plentiful, and the pork very lean. On the other hand, the absence of hair points to a super-abundance of fat. The head should be moderately large, and the neck fairly long; the snout fine, the space between the eyes rather wide, the ears erect and not drooping over the eyes, the shoulders large and wide, the back moderately level, the body compact and not too long, the loins of good width, and the bones neither too fine nor coarse.

Thorough-bred boars should be used for breeding

It will always be possible to select good boars for breeding from the progeny of imported stock. For instances see plates 9, 16, 4, 17, and 7. "Prince Victor" is an excellent type of mid-white, strong and vigorous, and produces superior stock. "Hollywell Swell" was bred in India from imported parents—"Lord Ormond" being the sire. "Duke" was also bred from imported parents, with "Lord Ormond" as sire, but he is useless for breeding as can be seen from his photograph, having developed too much fat in consequence of deformity. "King William" is a mid-white boar bred in the country from stock imported from Sanders Spencer. By a little care and attention, excellent boars for breeding can be produced, and importation need only be resorted to for the introduction of new blood.

The selection of boars.

The health of the boar.

The health of the boar is another important point, as hereditary disease is almost certain of perpetuation in the progeny. Do not breed from a leggy beast. What is required are pigs with short legs, compact bodies, good girths and active. These points will produce good progeny. It is extremely difficult to get natives in India to manage boars in the proper manner. In breeding, mistakes frequently occur. When the serving is entrusted entirely to native servants, they allow the boars to cover sows indiscriminately and without any regard to the extent of work a boar is capable of doing in a day.

Successful pig-breeding in India dependent on strict attention to principles of breeding.

If the principles of breeding are strictly followed, and boars and sows possessing good points are mated, pig-breeding must be successful in India. In the selection of sows many failures have been experienced. Success or failure depends chiefly upon this, which may be called the foundation of successful breeding. Careful selection is therefore absolutely necessary and any neglect is certain to result in indifferent progeny and consequent retrogression in quality. Every effort should be directed to breeding large and well formed litters at the least possible cost. A sow which always produces large litters is valuable, and her offspring are known generally to inherit this good quality. There have been many instances where the progeny of sows throwing small litters have been bred from with the same defect as their mothers. Some sows may give large litters, but as they are unable to nourish them, many of the litter die off. It is an important point, therefore, in a sow that she should be capable of nourishing her litters. The progeny of some sows develop quicker than those of others. The characteristics of a good sow are, therefore, the tendency to large litters and the capacity to nourish them ; the offspring must be rapid growers and come to maturity quickly : the sows should be long, large, roomy and healthy ; the head should be moderately long, but not coarse ; the snout turned up with saucer face. The snout of a Berkshire sow is, as a rule, only slightly turned up, and in many cases it is straight. Short thick heads, coarse necks and shoulders, and long legs are points which should never be found in a good sow. The back is slightly arched and often level and moderately wide. Her hair also is generally long and abundant with few or no bristles

Housing and management of boars.

The styes for boars should be spacious, and each boar should have an outer yard of his own, separate grazing enclosures being allotted to each as it is dangerous to allow boars together because they are certain to attack each other. Boars should be well fed and exercised. If kept in small styes without exercise, they rapidly put on fat and become inactive. Boars should begin service when about 8 months old, but for some time, that is till about 14 months old, they should be used sparingly. "Lord Ormond" is now six years old, and is no longer in service. In India, probably, boars should not be used after five years service. On no account should they be allowed to run loose with sows, as is the case with country boars.

CHAPTER II.

The Management, Feed and Keep of Pigs.

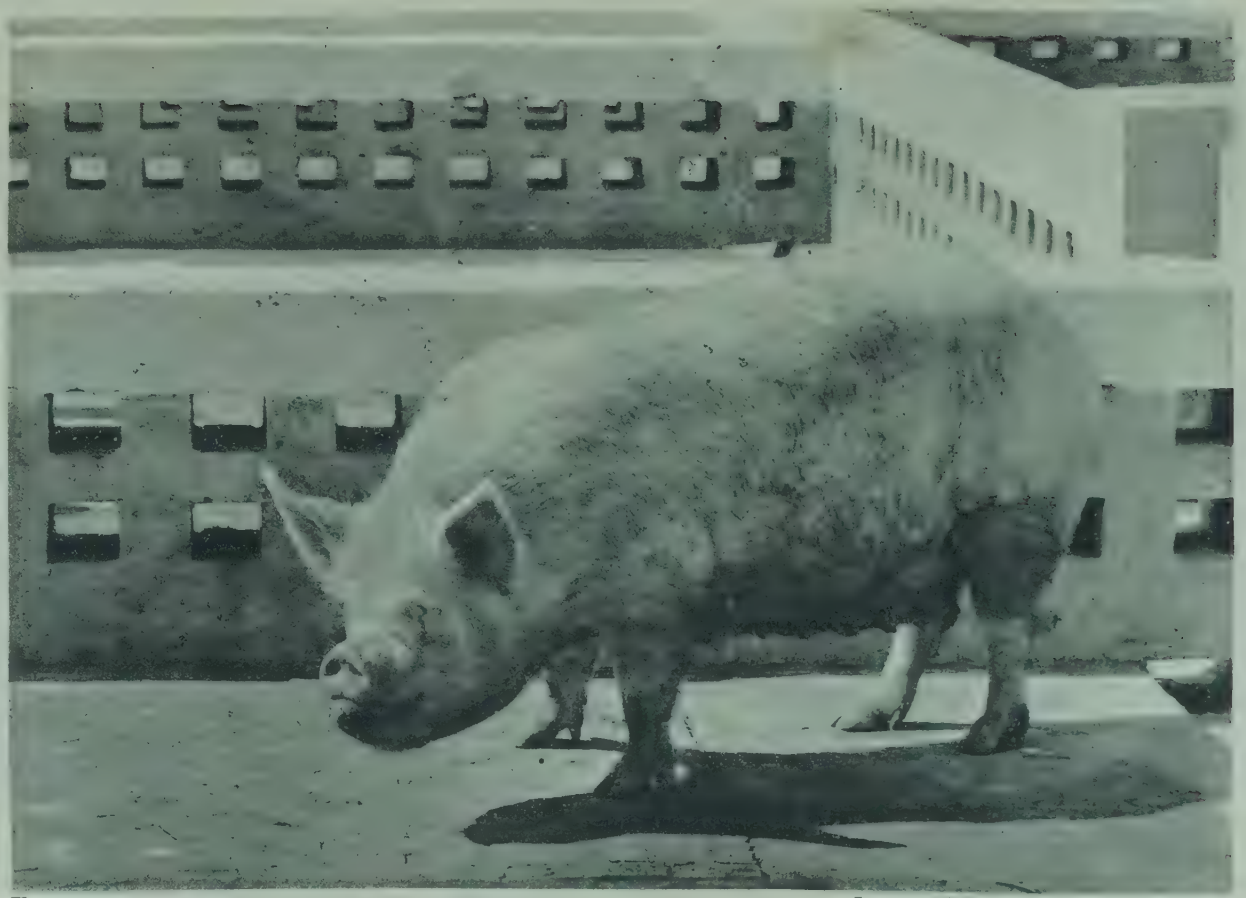
Housing and management of breeding sows.

Sows should be housed separately and always kept clean. It is wonderful how quickly pigs can be taught to be clean ; and as the health of all animals mainly depends on good sanitation and wholesome food, careful attention to these matters is imperative.

Evil consequences of serving immature sows.

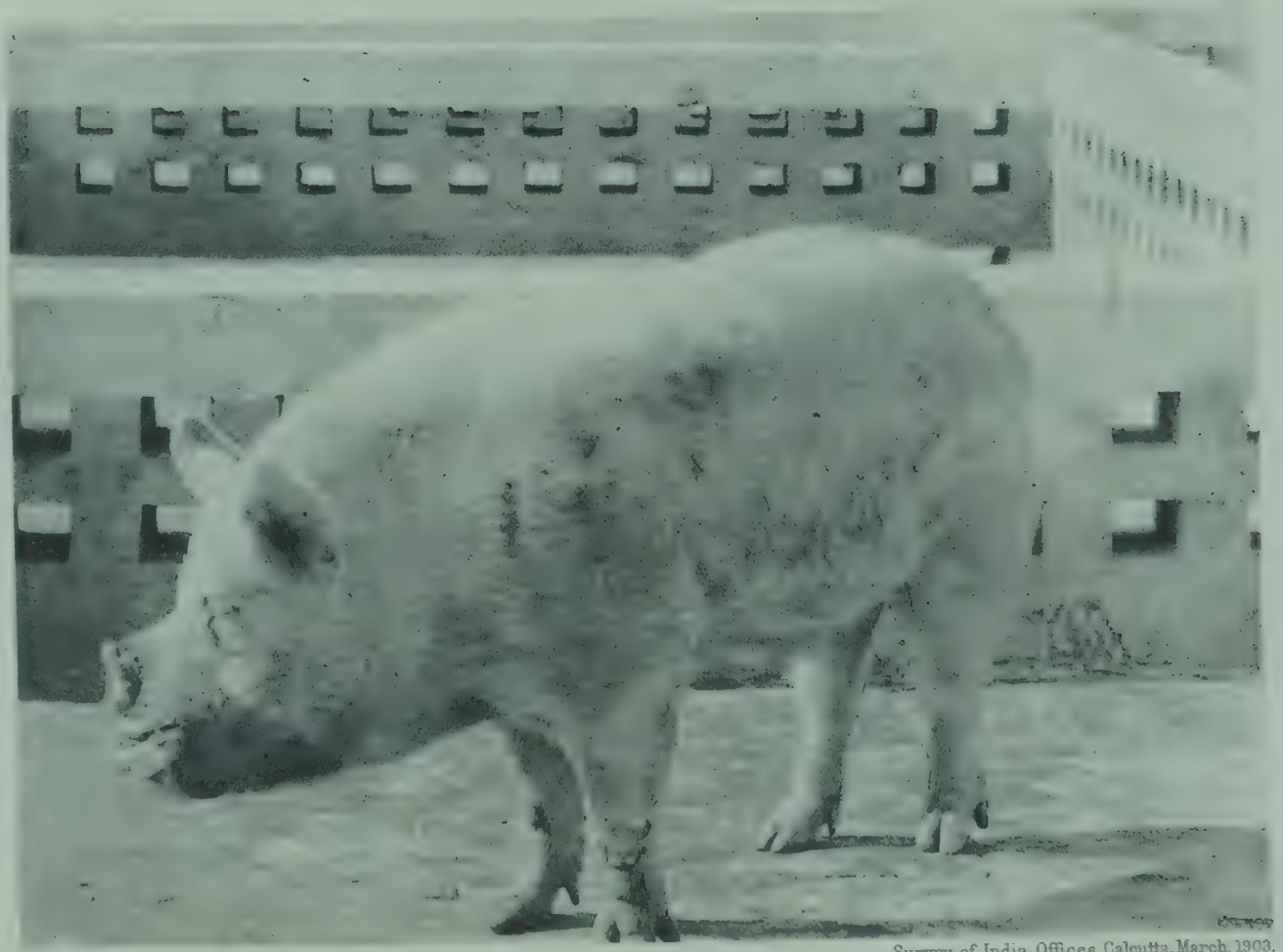
Sows should be served when about 8 months old, and thus have their first litter at 12 months. In India, the tendency is to allow them to be served earlier, which, according to experience, is most injurious, as not only are the growth and maturity of the sow injured, but the offspring must necessarily be small and the sow have very little nourishment for her young. Degeneration must follow the practice. Many failures have resulted from servants entrusted with the charge of the piggery disregarding this precaution. Sows come into season in India more quickly, perhaps, than in colder climates, and if boars are allowed to run loose with young sows premature crossing cannot possibly be avoided. Sows generally attain their full maturity when about two and a half years old. Young sows should be provided with

The management of farrowing sows.



Photogravure. Survey of India Offices, Calcutta, March, 1903

A mid-white sow, bred from imported stock.



Survey of India Offices, Calcutta, March, 1903.

" King William "—a 3-year old mid-white boar, bred from imported stock.

The management, feed and keep of pigs.

plenty of good grazing and have unlimited exercise; in fact, while growing, they should always have full liberty. They should be kept in a growing condition and not allowed to grow fat. Until they litter, vegetables, *chuni* and separated milk are a suitable diet for them. After that they will need more nutritious food. While young, grain of any kind may be given them in limited quantities, but after farrowing, the feed should be of a character to promote the milk secretion. In addition to these feeds a little gram and bran may be given. A sow after farrowing needs laxative food, and should on no account be allowed to become constipated. The milk of some sows does not appear to agree with their young. When this happens, a small quantity (say, a teaspoonful) of sulphur in the mother's food is beneficial, or some charcoal may be given to her to eat and a similar quantity of bicarbonate of potash mixed with her food.

Number of litters in a year.

The main object to be aimed at in rearing sows is to cause them to grow quickly, with large frames and good muscles. When they grow too fat, as they often do, they fail to retain. It is advisable when a young sow is about to be put to the boar to shorten her allowance of food, and when she has been covered, to feed her well. This is recommended as tending to increase the number of the litter. Two litters should be obtained annually in a well managed piggery — but if the breeding is entrusted solely to the natives, not more than one can be expected. Breeding sows should never be allowed to run down in condition, as they are then very slow in coming into season. Natives generally neglect to allow sows, when in season, to run with the boars and this retards their breeding. Again, if a sow is not in good health, she will not come into season.

Causes which retard breeding.

Period of gestation.

The period of gestation with a sow is 112 days. When sows are in young, care should be taken that they neither grow too fat nor fall off in condition, and they should have plenty of exercise. When about to farrow, a sow should be placed in a stye by herself and kept entirely apart from the other pigs. By this means, she becomes accustomed to her quarters before farrowing, and loss in the number of her litter is prevented. If possible, a boy or servant should always be present when a sow is farrowing, and it is advisable that he should be one whom the sow knows. The after-birth is removed instantly, care being taken that the sow does not eat any portion of it. If sows once start doing this, they soon learn to eat their young. Very few cases have, however, been known of sows eating their young, but whenever this has occurred they have been immediately fattened and killed. Draughts should be carefully excluded from the styes, as the young ones are likely to catch cold and die. The bedding should be changed every week, and on no account should the stye be flushed out until the little pigs are four weeks old. After farrowing, a little molasses is generally given to a sow for four or five days, or about an eighth of an ounce of chlorate of potash is mixed with her food daily for about eight days. This promotes milk secretion of a healthy character, and also makes the litter healthy.

Sows eating their young.

The management and feeding of young pigs.

Milk possesses all the elements requisite for the growth and maintenance of young animals, and for the first three or four weeks after their birth, the mother's milk is quite sufficient for the little pigs. The sow should be fed largely on separated milk, bran, vegetables and roots of various kinds. In the summer months in India, melons and mango seeds also have been fed with good results to sows with litters. The kernels of mango seeds are both fattening and milk-productive. When the young are able to take more than their mother's milk, they should be given a little butter-milk or separated milk soured, or the mother's milk, if scanty, may be supplemented by a little whole milk for a few days. As they grow, a little gram or barley-meal mixed with the milk is very good. On no account should the condition of young pigs be allowed to deteriorate, or much loss will occur. If young pigs are not carefully nurtured, they rapidly fall off in condition and seldom recover—never afterwards equalling pigs whose development has been continuous from birth. Young pigs are susceptible to many influences which interfere with continuous progress, but with care and attention, the risk from these is minimised.

Causes which seriously affect the condition of young pigs.

Bronchitis, white scour, and sore tails cause a great falling off in the condition of young pigs affected by them – the two first named being even dangerous. For sore-tails, (which frequently ends in the tail or a portion of it falling off,) use carbolic ointment

on the appearance of the first symptoms. A strong solution of alum and saltpetre has also been found efficacious.

When young pigs should be weaned.

Young pigs when in good condition should be weaned at from 9 to 10 weeks; but, if delicate, they may be allowed to remain with the mother till they are 3 months old. After being weaned, young pigs should be allowed good and ample grazing, as this is essential for their development. It is sometimes thought to be economical not to keep young growing pigs in good condition, and merely to let them get on as best they can on scanty food until within a few months of killing, when they are given as much as they can eat. As with all young and growing animals, so with pigs, it is a matter of the greatest importance that they should be kept in good condition while growing, or serious loss is certain to occur. The young ones will not develop either in frame or flesh, and their poor condition will render them always more liable to disease. As casualties occur most frequently among young pigs, their styes should be well-ventilated, and kept warm, dry and clean, as well as free from draughts. They should be fed often during the day, and not less than three times.

Castration.

All young boars not intended for breeding should be castrated before they are weaned. The operation is a simple one and the wound heals quickly. The spaying of sows is more difficult, but it is not an absolutely necessary operation. A trained man should be kept for this work as amateurs are liable to rupture the animals.

Pigs kept for profit.

Pigs can only be kept for profit by the exercise of wise judgment: and the good results that are attained are ample reward for close attention to every detail in connection with economical feeding and the avoidance of wasteful and expensive material.

Management and feeding of store-pigs.

Store pigs should be grazed and fed on separated milk with a little *chuni* added. Although economically fed, no effort should be spared to prevent any falling off in their condition. Grazing is very beneficial; besides giving them exercise, it keeps them in a good healthy condition in which they thrive rapidly. Without good grazing, it would be impossible to make pig-breeding pay, as if fed entirely on grain, the cost would be prohibitive. Instances have been known, where pigs, fed entirely in the stye and receiving no graze, have been found smaller and lighter in weight than those which were grazed. They should be well grazed and receive separated milk (soured) until within 2 or 3 months of killing, when they should be stall fed. Pigs of about 8 months old should produce from 120 to 140 lbs.

Important points connected with management of store-pigs.

To sum up, the following points must be strictly observed in the management of store-pigs :—

(1) Feed economically until the fattening period arrives and keep the animals in a growing and healthy condition, so that they will thrive quickly and be ready for fattening early.

(2) Do not allow the pigs to fall into poor condition by starving, and give them plenty of exercise.

(3) Provide good and extensive grazing in order to promote the health and muscular condition of the pigs.

Management of fattening pigs.

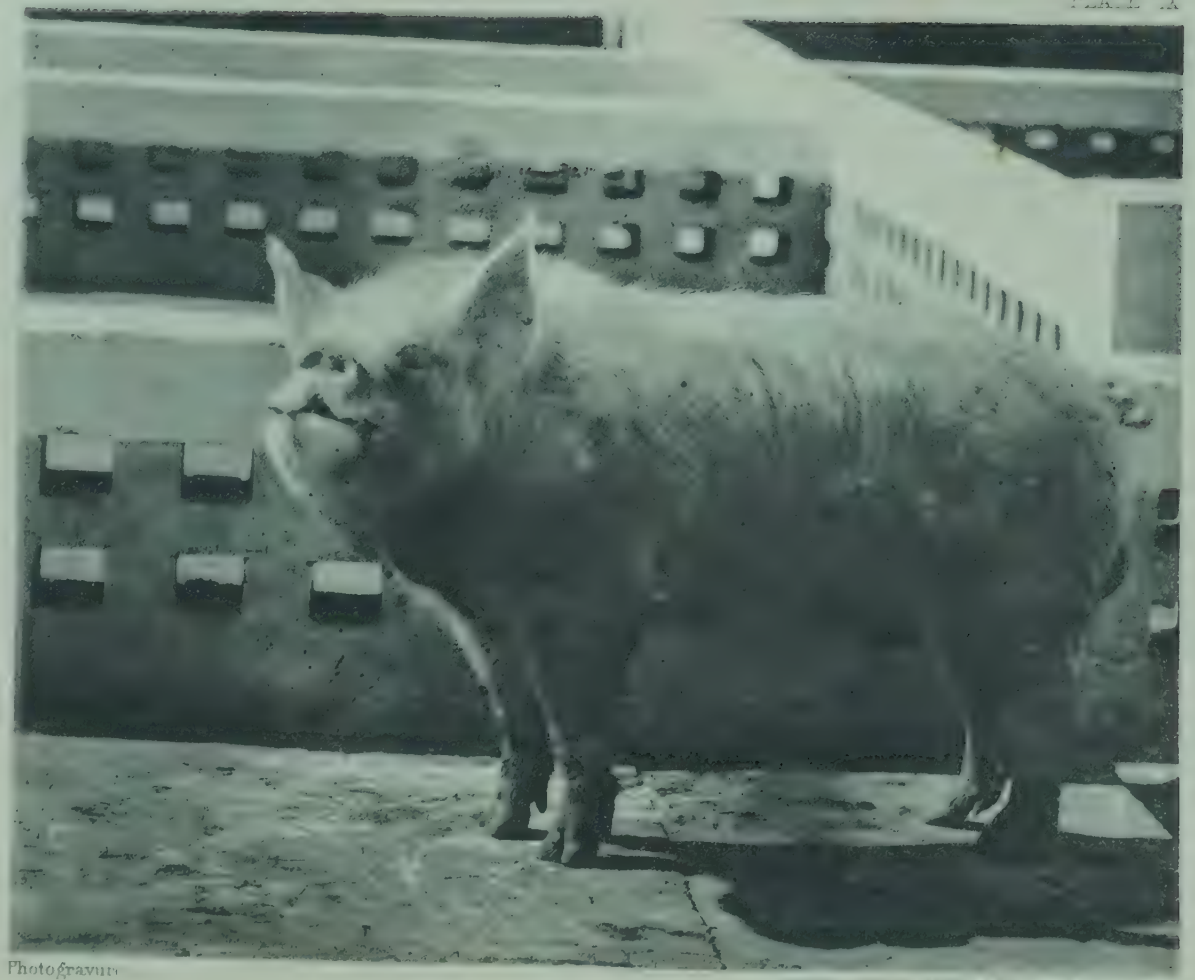
In fattening pigs, the principal object should be to produce the largest weight of valuable meat at the lowest possible cost. Many grave errors have been made by those entrusted with the care of pigs, owing to ignorance of the constituents of the food fed to the pigs. The character of the meat varies according to the composition of the food consumed. Thus, foods rich in carbo-hydrates are fat-forming, while those rich in albumen or proteids are muscle and flesh-forming. A practical knowledge of the effects of the various kinds of fodder is therefore of the utmost importance in feeding. As before explained, the great demand in India is for lean or streaky bacon, and efforts should be continuously directed towards finding out the influence which each kind of grain has on the character of the meat. During the past nine years, many experiments in this direction have been made at Allahabad, with cooked and uncooked food, with whole grains, with grains finely or only partially crushed, and with grain finely ground. The results obtained point clearly to the superiority of cooked food, wherever it is possible. It diminishes cohesion, and so changes the texture as to render mastication easy. The digestibility of the meat also is materially increased. Cooked food is not only more palatable to the animals, but there

Advantages of cooked over uncooked food.

Photogravure

Survey of India Off

A 3-year old mid-white sow—produces excellent stock.



Photogravure

"Prince Victor," a 2-year old mid-white boar, bred from imported stock.

is less wastage. Over-cooking is, however, not desirable, and should be avoided. Before cooking, all grain should be finely ground, or a large quantity will pass directly through the animals and be wasted. In this way, grain fed whole or only partially crushed may be collected daily after passing undigested through an animal's stomach and this of course means serious loss. When therefore the food cannot be cooked, all grain should be very finely ground. Vegetables are very good for pigs, and especially so for sows : but when given to fattening pigs, they should be cooked with the grain. Separated milk was for many years fed to the pigs at Allahabad, but without any apparent benefit. It was ultimately found that it passed through them without doing them very much good. It is now, however, always soured before being fed and when mixed with potatoes or grain, the results are extremely good.

Vegetables.

Separated milk.

The following are the grains best suited for fattening pigs in India. Maize or Indian corn produces fat, and the meat of pigs fed solely on it has always been pronounced too fat. Gram, on the other hand, produces both flesh and fat and experience proves it undoubtedly the best grain for fattening pigs. It is generally ground, cooked, and mixed with separated milk. When gram is given whole or only partially crushed, it is very difficult to digest : so that, if not cooked, it must be ground finely. *Chuni* should not be given alone, but in small quantities mixed with other grains to make up bulk. It is generally very much cheaper than other grain. Millet, unless cooked, should not be fed to pigs, as they derive but little benefit from this dry and heating grain. Where, of course, it is cheap, it may be given, thoroughly ground, cooked, and mixed with other grain in the same way as *chuni*. Potatoes, cooked and mashed with soured separated milk, make excellent feeding, and as they are obtainable cheaply in the market in the winter months when pigs are ordinarily fattened in India, they form a good and economical food. It is probably not widely known that the kernel of the mango stone is about the best flesh and fat-forming food for pigs. The seeds are collected from the bazaars and other places when the fruit is in season, and they are thrown to the pigs in their shells. The pigs amuse themselves by extracting and eating the kernel. Many instances have come under the authors' notice of pigs in very poor condition being fed on mango seeds and becoming fit for any butcher's shop in less than six weeks. Kanah, husks of rice, is also largely used by the natives, and when given with other grain, it makes a fair feed, but care should be taken that it contains no sand.

Grain best suited for fattening pigs.

On the plains of India, the bacon-curing season extends generally from the 15th of October to the 15th of March, and the pigs are accordingly stalled for fattening about the 1st of August. The number placed in each stye will vary according to the size of the pigs, and care should be taken that they are never changed, *i.e.*, the same pigs always remain in the same stye. Any pig straying amongst strangers will be badly treated, and must, in consequence, fall off in condition. Hogs and yelts should be stalled separately and when once shut up for fattening they are allowed no exercise beyond merely being taken out of the stye while it is being cleaned. The native swine-herds are generally *Pasis* and *Khatiks*, and work satisfactorily if paid well.

Bacon-curing season.

When being fattened, pigs should be fed punctually, three times a day — early in the morning, at midday, and in the evening, and at each meal they should be allowed to fill their bellies. During the first fortnight, they will eat gluttonously, but after that they eat less each day until they are ready for killing. The following has been found a very suitable feed : — grams 4 parts, maize 2 parts, chuni, (or good kanah) 1 part and as much separated milk as is obtainable from the dairy. As the pigs improve, the chuni may be discontinued. If it is not possible to cook the food for all three meals, the morning and evening feeds only need be cooked, and the midday one given uncooked ; but it should consist of vegetables, *e.g.* cabbages, carrots, turnips, potatoes, etc., or mango seeds. Troughs for feeding should be placed in each enclosure outside the various styes, so that the pigs can be easily driven to and from their styes without risk of contagion, which attends the system of feeding all the pigs at the same troughs in a general enclosure. After each feeding, the pigs should be removed to a space in the yard set apart in which they are trained to drop their excreta, and then taken back to their styes, which they should not be allowed to leave again until the

System of fattening.

next feeding time. If proper attention is paid to the care and feeding of pigs, the extra flesh put on during the fattening period of about two months will more than cover the expenditure incurred in fattening, but, on the other hand, any bad management will ruin the undertaking. Charcoal should be given to the pigs twice a week, as it helps them to digest their food.

Cleanliness insisted upon.

Pigs should be kept scrupulously clean during the period of fattening, and washed once a day. It will be observed that sows and yelts fall off considerably in condition whenever they come in season. Spaying would obviate this, but the operation can be dispensed with, as if a sow is served about a month before she is killed, it will prevent any falling off in condition and the fœtus will not have come to life by the time the sow is killed. Mistakes are liable to happen if yelts are allowed to be served too soon, for in such cases they are heavy in young at the time they are fit for killing. Such serious mistakes should by all means be avoided; and if a fattened sow is known to be heavy in young, she should certainly not be killed. After farrowing, she should be fattened and killed for bacon during the following season.

A farm manager after some experience in breeding and fattening, ought to find no difficulty in determining the best class of pig for his various requirements. He should have marked the quick-growers, the large-framed and weighty animals, and those which have put on flesh and meat most quickly. As sausages are best when made from the back part of the pig, all the fattest animals should be selected and, generally, animals from 10 to 12 months old are best suited for this purpose.

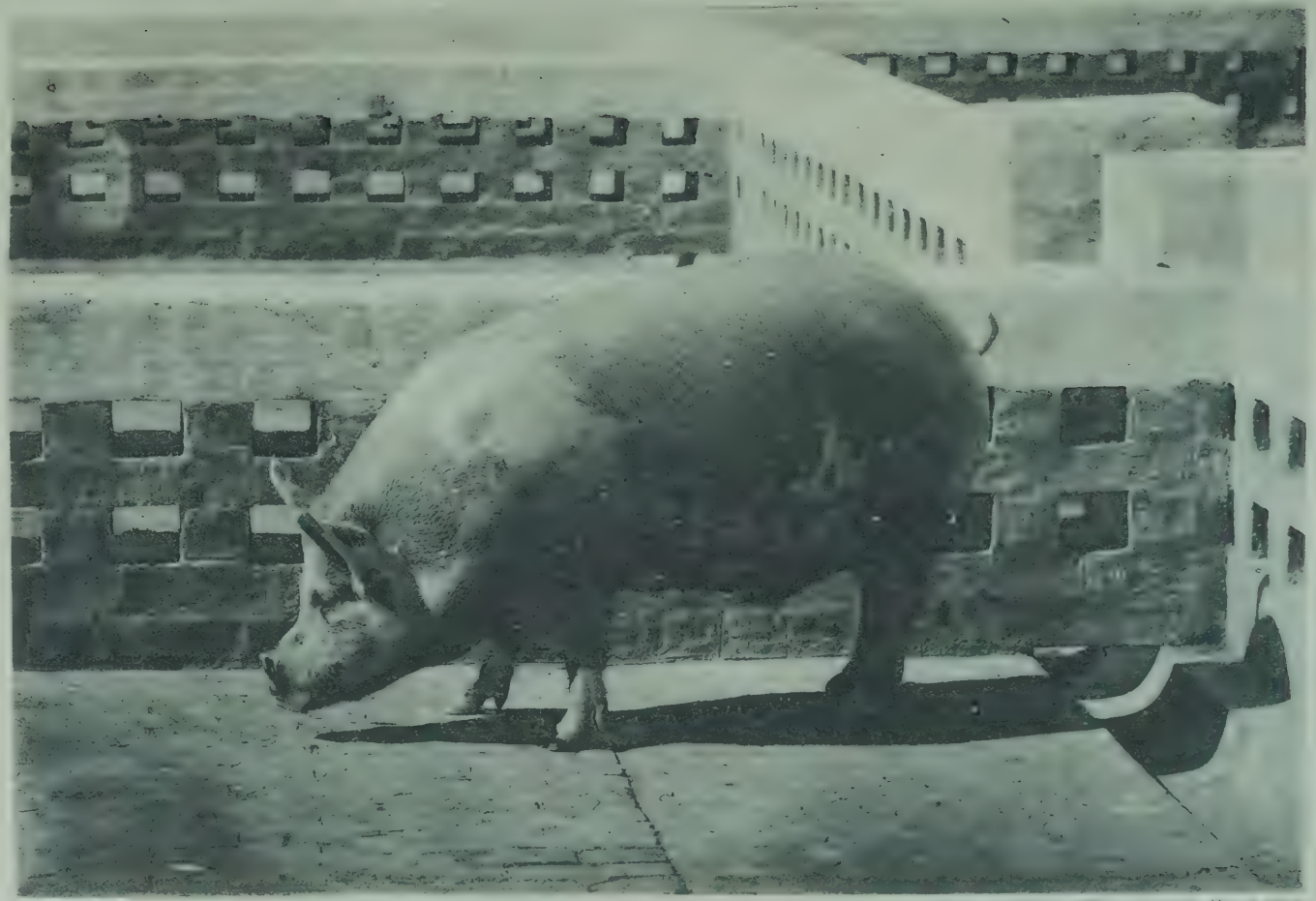
Segregation of sick pigs.

All sick pigs attacked by sickness should be at once removed, for if the disease happens to be contagious, the entire herd will be soon affected, as disease spreads rapidly among swine. Foot and mouth disease has broken out among the fattening pigs at Allahabad just when they were ready for killing, and the pigs deteriorated to such an extent that considerable expenditure had to be incurred in restoring them to their original condition for killing. Before pigs are killed, it should be carefully ascertained that they are in a healthy condition.

The close association between dairying and pig-breeding.

There is so close an association between dairying and the breeding of pigs for the manufacture of bacon that it may be safely said that nowhere in India at the present time is it possible to procure bacon manufactured from home-bred pigs except where the pigs are kept for pleasure and not for profit. It would certainly be possible with a little care and attention to make bacon-curing a profitable undertaking in India. On military farms, however, the object is to supply the soldier with wholesome piggery produce at as low a rate as possible, and little or no profit is either made or expected. The ordinary native pork and bacon vendor succeeds in disposing of his supplies in cantonments at 2 annas per pound for bacon, 3 annas for ham, 1½ anna for fresh pork, and 1 anna for sausages, while for the pig's head he gets 4 annas, and for each trotter half an anna. To any one with even the slightest knowledge of the bacon manufacturing industry, these rates are simply ridiculous, and how the supplier can afford to sell at these low rates puzzles many. Contractors in cantonments, while keeping a few specially fattened pigs for show, and as a blind to the local authorities, get all their produce from the common village pig. The show pigs, of course, are not killed till the end of the season, but the village pig is brought in daily, killed and salted. Those acquainted with India do not need to be told how the village pig subsists, and it is notorious that it is actually the village scavenger. The contractor merely salts the meat for three days and after being sun-dried for a day, it is sold the next day as bacon. The sausages are made entirely with the hand; the mincing being done either with the hand or in a small sausage machine, and after the admixture of inferior bread and many other ingredients, the meat is forced by unclean thumbs into dirty guts through a tin funnel often covered with rust. The guts are neither turned nor properly cleaned, and flies, hairs and other most objectionable matter are almost invariably intermixed with the sausage meat. It is only necessary to open the carcase of a country pig to realise the terrible risk to which consumers of its flesh are exposed. In only too many cases, the meat teems with worms or their germs. The ordinary cantonment contractor feeds his show village pigs for a few weeks before killing them, but this feeding makes no

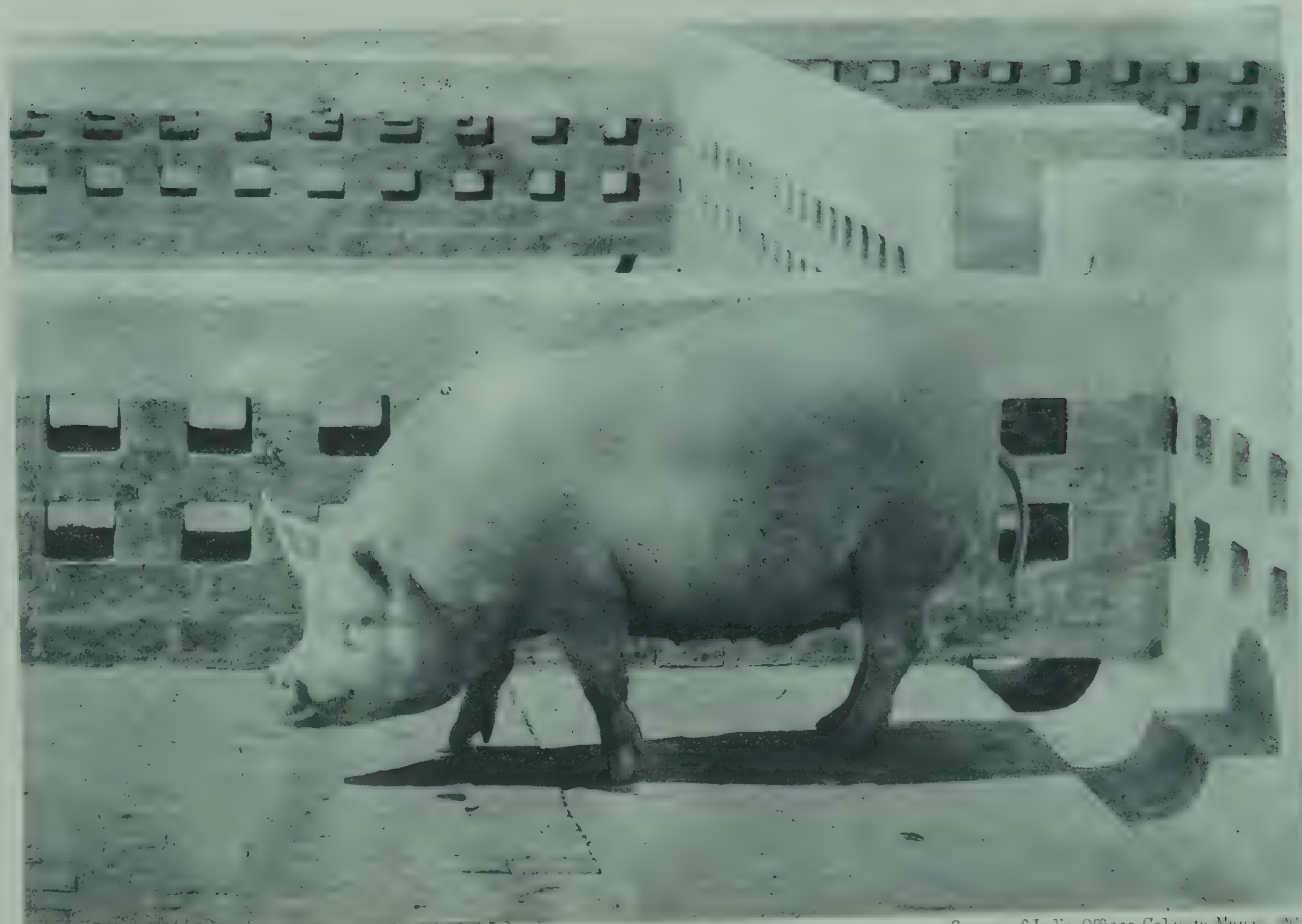
The native contractor.



Photogravure. Survey of India

A cross-bred boar, 1 year old by Berkshire boar and large white sow.

PLATE XI.



Phot...

Survey of India Offices, Calcutta, Mar...

A 12 months old hog—Berkshire boar and mid-white sow.

appreciable change in the quality of the meat, while it in no way minimises the dangers to which the consumer is exposed and it is surprising that people with a full knowledge of these facts, continue to patronise such filthy stuff. There can be small wonder if consumers suffer—often fatally.

Produce consumed by troops.

It may be said, generally, that British troops in India consume a very considerable quantity of bacon, ham and other products of the pig, and it seems, therefore, almost imperative that piggeries should be established in every cantonment in connection with the military dairy. The skim or separated milk from the dairy, while improving the quality of the meat, materially reduces the cost of feeding the pigs. It is absolutely necessary that the pigs should be fed on good and wholesome food ; and all objectionable matter should be rigidly guarded against, as they would defeat the object. In order to frame an estimate of the requirements of the troops, the following data will be useful, as showing the quantities supplied by a military piggery to a garrison of 1,100 men during three months :—

	lbs.
Bacon	6,218
Rolled spiced bacon	2,500
Ham	2,160
Sausages	6,000
Pork (fresh)	2,867
Pork pies	3,000
Heads	200
Fore feet	400
Hind feet	400

Previous to the importation of pigs from Europe, the country pig used to be purchased and fattened for three months—which was considered sufficient to purify the meat : but with the knowledge gained by personal verification, the authors hold that the feeding did little more than add to the weight, and it is satisfactory to record that the practice has been abandoned.

Pig-styes.

There are various descriptions of pig-styes, but though all may be admirably adapted for a European climate, most of them would be quite unsuited for India. In plate No. 19 will be seen a piggery which has been in existence and served its purpose very satisfactorily for many years. It is almost square, with compartments for boars, young, fattening, and farrowing pigs. Each pair of compartments has a yard in front in which the pigs are fed and the litters get their exercise. The floor of the compartments is bricked and the walls are cemented to a height of about 3 feet. A shallow drain runs through every compartment, which carries away the slush water. During the summer months, by blocking the lower end of this drain, each compartment is flooded with water to a depth of a foot, and the pigs enjoy a good wallow, in a considerably reduced temperature.

Ventilation.

Pigs require plenty of ventilation, and for this reason perforated (rather than solid) masonry walls should divide the compartments, so as to admit of a free current of air right through the stye. If perfect cleanliness is insisted on and the styes are flushed down daily, this current of air will be wholesome and cool. The roof should be of double tiling, the height at the ridge being about 15 feet from the ground. Low roofs mean a very much higher temperature in the styes. In the pig-stye illustrated in plate No. 19 as many as 450 pigs have been kept at the one time and with the best results—boars, young pigs, sows and fattening pigs—cleanliness and sanitation being secured by good drainage and daily flushing.

Distance of piggery from dairy.

A piggery should not be closer than 600 yards to a dairy or cow-yard and the site selected should be in the opposite direction to the prevailing wind. Every piggery should be provided with a recreation yard immediately adjoining it ; as it is absolutely necessary, in India especially, that pigs should get their exercise on conserved land, to prevent them eating filth. The yard should be fairly large—a convenient size being 500 yards by 400 yards.

Slaughter house

The slaughter-house should be some distance away from the piggery, for the sake of the pigs as well as for sanitary reasons. In the large factories in Europe, every-

thing is done on the same premises, but as the maximum number of pigs daily slaughtered on a military farm will probably not exceed 8, the European practice is unnecessary in this country, and its expense is prohibitive. The slaughter-house should be as close as possible to the chill and curing rooms, but this is not always possible on sanitary grounds. At Allahabad, hitherto, the bacon has been chilled by ice, and the slaughter yard and curing rooms (20 feet × 18 feet), are contiguous.

As this Manual is only intended to serve as a guide to Farm Managers, the authors consider they have said enough regarding their personal experience of pigs in India, and therefore pass on to the more interesting part of the work, *viz.*, the manufacture of the produce.

CHAPTER III.

Manufacture of Bacon, Ham, Sausages, etc.

Killing.

The best time for killing in India is in the evening, when the day-temperature is lowest. When driven into the slaughter-house, the pigs are seized, one after the other, by a hind leg which is at once tied with a rope, with a hook affixed to it and the animal is hoisted by this on to a cross-bar. The butcher (a thoroughly trained man of the *khatik* caste) then sticks each in turn with a double-edged knife, passing it through the fleshy part of the throat and behind the breast bone, and so severing the jugular vein or *aorta*. In doing this, care has to be taken to send the knife straight home, and to be sure that it does not stick in the shoulders nor touch the heart. Many consider this process cruel, but it is surprising to observe how quickly life becomes extinct. The sudden rush of blood suffocates the pig and death ensues within a minute or two. The inverted position allows the blood to escape freely, and as it falls it is caught in a clean vessel and reserved for the manufacture of black puddings, a little salt and hot water being mixed with it to prevent coagulation.

Scalding.

The carcase is soon afterwards let down into a tub of water, — sufficiently hot (about 180° Fahr.) to remove the hairs and outer skin. A large copper vessel is used for warming the water and a tub for scalding. The carcase is turned repeatedly in the tub and kept well under water until the hair comes away easily from the ears and trotters. It is then placed on the scuttling table, where the hair is quickly removed with a bell (cone-shaped iron) or tin scrapers. The natives generally use knives specially made for the purpose in India. What hair remains after this process, is either singed or removed with a razor, but singeing is preferable as not only does it effectually remove the hairs but it hardens the skin so that it does not readily become slimy when the meat is salted, and it also admits of a certain amount of the coarser outer skin being removed. After singeing, the carcases are thoroughly washed with cold water and scrubbed with *pumice* stone in order to remove all dirt from the skin. The sinews of the hind trotters are next laid bare with a double cut, and under these a wooden gambrel is fastened. A rope is attached to the gambrel and the carcase is again hauled up on to the cross-bar. Here it is a second time washed with cold water, and then carefully cut open by an experienced butcher. When the intestines and offal have been removed, the inside is thoroughly washed with cold water, and the gristly part of the snout is cut to allow of the escape of the blood from the nostrils. The vertebral column and the head and feet are next removed, the sides being allowed to hang all night in the coolest part of the slaughter-house, so that the excess animal heat may escape into the atmosphere. In the absence of refrigerating plant, ice should be used for cooling the meat. After the kidney-fat, or flick-lard, has been removed, the sides are placed on the table, inside upwards, and ice is laid on top of them. It would of course be better if the ice did not touch the meat, but this cannot sometimes be avoided. Early the following morning, the sides should be cut up into hams and pieces as desired, and the trimmings and offal utilised in sausage-making.

Removal of the vertebral column.

Use of ice.

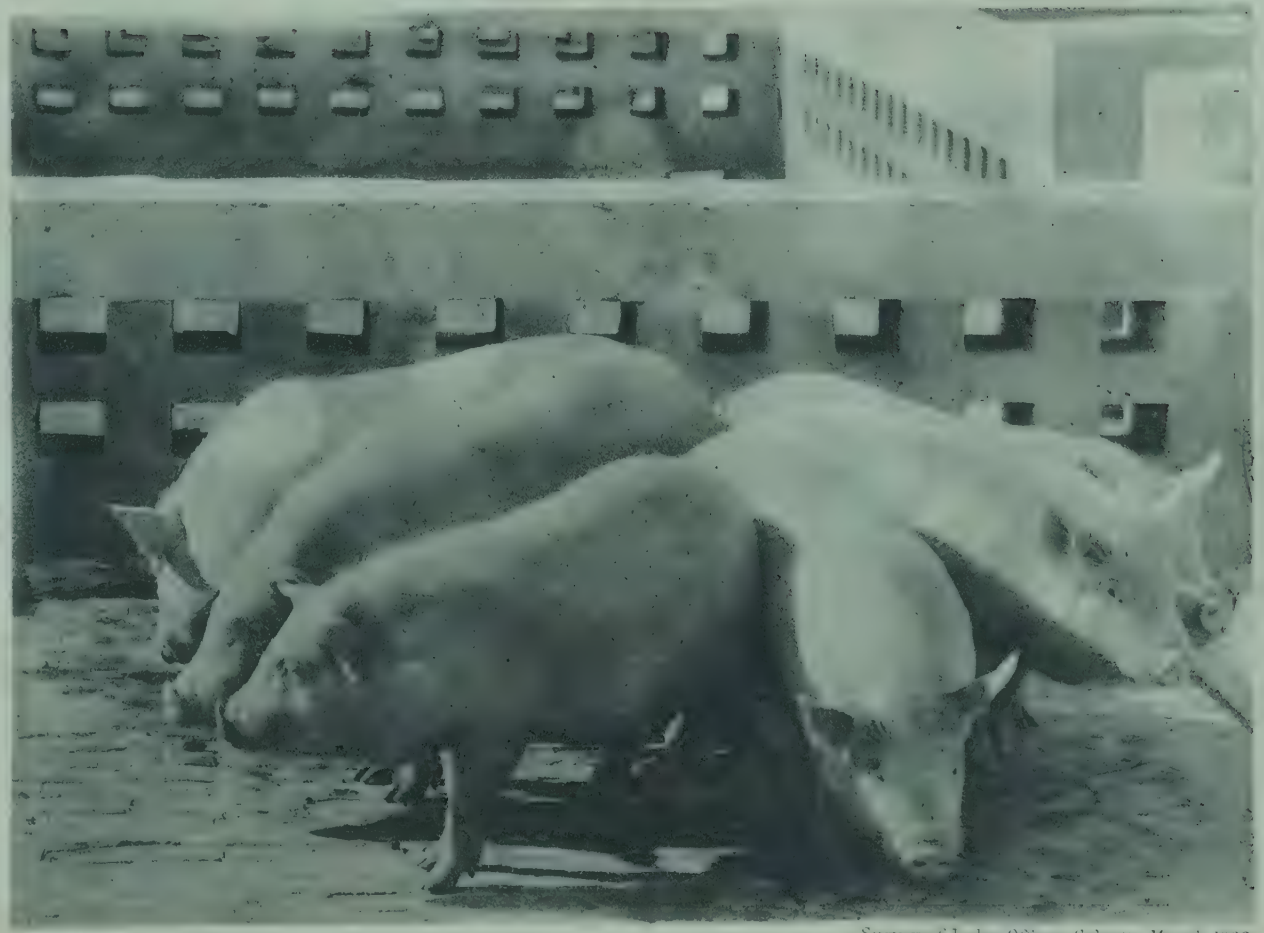
Proper temperature for salting.

Cleaning of sausage-casings.

The proper temperature for salting is from 42° to 45° Fahr. and this can be ascertained by inserting a thermometer into the meat. The sides should be well trimmed so as to make them look as even and regular as possible. The guts required for sausage-making should be scraped and cleaned, both inside and outside, by turning; they should then be thoroughly washed with lukewarm water and subsequently allowed

Photogravure. Survey of India Offices, Calcutta, March, 1903

A China sow, with litter of nine, 4 weeks old, by Berkshire boar.



Photogravure

Survey of India Offices, Calcutta, March, 1903.

A litter of store-pigs, 4 months old. Bred from mid-white boar and black Chuna sow. This cross matures quickly and produces

Manufacture of bacon, ham, sausages, etc.

to soak in a solution of antiseptic and salt. The bladders for containing lard are similarly treated. They are washed and scraped thoroughly and turned inside out before the lard is put into them. The heads are cut into three pieces and put into pickle (with the feet) to remove the blood. They are then injected with the pickling brine, and put into fresh pickle.

Theory with practice necessary.

After the authors had repeatedly failed to secure a reliable method for curing bacon in India, they were recommended to consult James Long's "Book of the Pig," and although it was of considerable use at the time, it furnishes but a very meagre outline of the process of curing. Its instructions were carefully followed: no rubbing was allowed, and the meat was salted and stacked exactly as directed. Ice could not be used as it was not obtainable; and the whole of the meat went bad within a few days. The authors thus discovered that the bacon-curing business was anything but a simple one, especially in India, and that it was one concerning which it was extremely difficult, if not impossible, to obtain any information from those already in the trade. It was not until 1897, when the Government of India was pleased to depute one of them to England to acquire knowledge in this particular branch, that any advancement could be made. Even, then, the way to knowledge was not an easy one, for after he had travelled all over Great Britain and inspected many of the largest factories, the proprietors resented his request for any hints in the industry. He then journeyed to Ireland, armed with letters of introduction to Messrs. Shaw and Matheson, who very kindly showed him over their extensive factories at Limerick. Only the former gentleman, however, consented to part with the secrets of the trade, and he very kindly directed his manager to show everything and to keep nothing back. Mr. Shaw subsequently received the thanks of the Government of India for his kindness, and the authors of this little pamphlet gratefully acknowledge the debt they jointly and severally owe him for his kind help to them in combating the many difficulties which meet the bacon-curer in India.

Irish bacon factories.

Bacon-curing.

Though jealously guarded, the process of bacon and ham manufacture is a very simple one, consisting, as it chiefly does, merely in the addition of preserving substances to the meat and allowing them time to reach and saturate the tissues. By this process, the development of bacteria is effectually checked and the bacon can be kept good for an indefinite period. The process which has been followed at Allahabad for the past five years has answered admirably and will now be briefly explained.

After the sides have lain in ice for 12 hours, and the temperature of the meat has been reduced to about 45° Fahr., they are placed on the salting table and injected with pickle made according to the following formula:—

Salt	50 lbs.
Saltpetre	5 „
Dry antiseptic	5 „
Cane-sugar (or *sukkar*)	7 „

Pickle must be of the requisite specific gravity.

These ingredients are mixed in 20 gallons of water and boiled. While boiling, the juice of about 200 sour limes is added and the peel is also thrown into the mixture to give colour to it. After the dirt has been carefully skimmed off, the pickle is allowed to cool and its strength tested. This should read 100° by Douglas' salinometer. The strength can be increased or lessened by the addition of salt and water, respectively, but the pickle must be at the proper strength when used. Cases have occurred where owing to its being below strength, when used without previous testing, large quantities of meat have been damaged. The pickle should be thoroughly cooled before use, and as the demand for it, even in a small military piggery, is considerable, it is well to lay in a stock. Hand pickle-pumps are sufficient for pickling, and they can be obtained in England. A knowledge of the proper places for the insertion of the needle can only be acquired by constant and intelligent practice. There are about 20 such places in each side, distributed over the gammon, round the bone, down the back, and at the collar. If particular attention is not paid to the injection, and a refrigerator is not available, failure will be inevitable. Unless natives are working under European supervision, they do not know the proper places at which to make the injections, and they neglect to use the salinometer. Before injecting

Manufacture of bacon, ham, sausages, etc.

the pickle the meat should be lightly rubbed with salt in order to remove any traces of blood, and the shoulder pockets should be specially and thoroughly well smeared with salt. After injection, the sides are again placed under ice, and by this means, the temperature is kept down for two or three days, while the tissues are being saturated with the pickle. On the second day they are removed to the salting table and again rubbed and injected. This is repeated on the following day, and the sides are then rubbed lightly with salt and placed on the floor of the cellar with their rind downwards. Here they are sprinkled with a mixture composed of saltpetre, cane-sugar and antiseptic in equal parts, and afterwards covered completely with salt. This done, they are piled, right and left alternately, with staves between to admit of the passage of a free current of air and of the pickle penetrating to the lower part of the ribs and thereby preventing the flesh from becoming too salt. The position of the sides is changed daily for about a week — those at the bottom coming to the top and *vice versâ*. A light rubbing of salt is also given them for five or six days. Though excessive rubbing hardens the lean portion of the meat, a light rubbing is necessary in India, even with the use of refrigerating plant and especially if an easterly breeze is blowing. In clear bright weather, with a westerly wind, the meat can ordinarily be kept at a low temperature—in which condition it absorbs the salt freely; but if the weather is cloudy or inclement, and an easterly wind prevails, the salt gradually melts away without penetrating the meat. These conditions of atmosphere must always be carefully observed or serious loss will result. It is safer not to kill in inclement weather as, with every attention at each stage, it is no easy matter to protect the meat from injury. After remaining in salt from 12 to 14 days the sides are piled upside down, the rind uppermost, and left so for 4 or 5 days to admit of the pickle draining off. The curing is now practically finished, and the sides can be washed—first in lukewarm water and then scrubbed with a hard stone to remove all dirt and grit from the interstices and creases of the flank, shoulder, etc. Washed, finally, in a solution of diluted antiseptic, they are rubbed and hung up to dry. When bacon is required for immediate use, as is generally the case in military farms, it can be cured in 8 days, but if it is intended for keeping, the period of curing as given above cannot be shortened. When cured, the sides should be hung in a well ventilated room to dry, the temperature of which should be kept at 80° Fahr. If they are to be smoked, this should now be done.

Light rubbing essential.

Climatic influences.

Period in salt.

Drying.

Price of bacon.

As a general rule, in all military piggeries, a uniform price is fixed for all bacon but, for retail, each piece is priced separately. The various pieces in a side of bacon are given below in the order of their value :—Leanest part of loin : loin, prime cut, thick streaky : corner of gammon : prime cut : (back ribs) top or thick, streaky, thick back thin streaky : prime part of collar : gammon hock : end of collar : flank and fore hock.

Curing hams.

Hams are cut and shaped after being cooled in ice. They are then placed for 24 hours in a tub of the pickle used for curing, and ice is still applied. The pickle removes the blood from the veins. After this, they are again rubbed and the veins pressed to remove any blood that may still remain. A rubbing with salt is now given, and the hams are injected with pickle made up of the following ingredients :

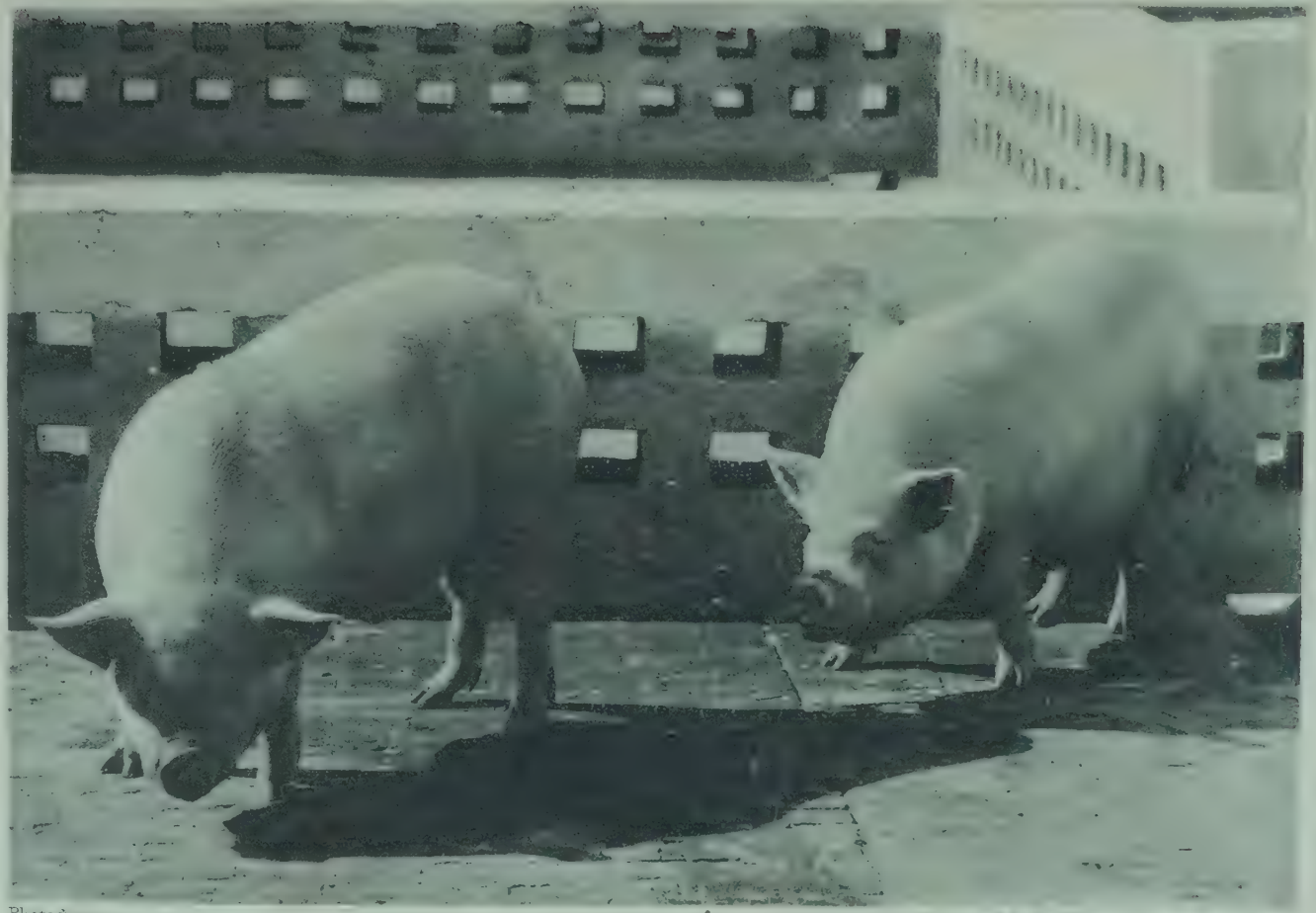
Salt	50 lbs.
Saltpetre	5 „
Cane-sugar	7 „
Antiseptic	5 „
Vinegar	2 qts.

Instead of vinegar, the juice of 400 sour limes can be used.

Parts to be pumped.

On no account should the pickle in which the hams were first placed be used at this stage. In fact pickle should never be used a second time until it has been boiled and the blood removed from it, after which it can again be brought up to strength. There are about 8 places in the ham where the needle of the pickle pump ought to be inserted : but particular attention should be paid to the part round the bone.

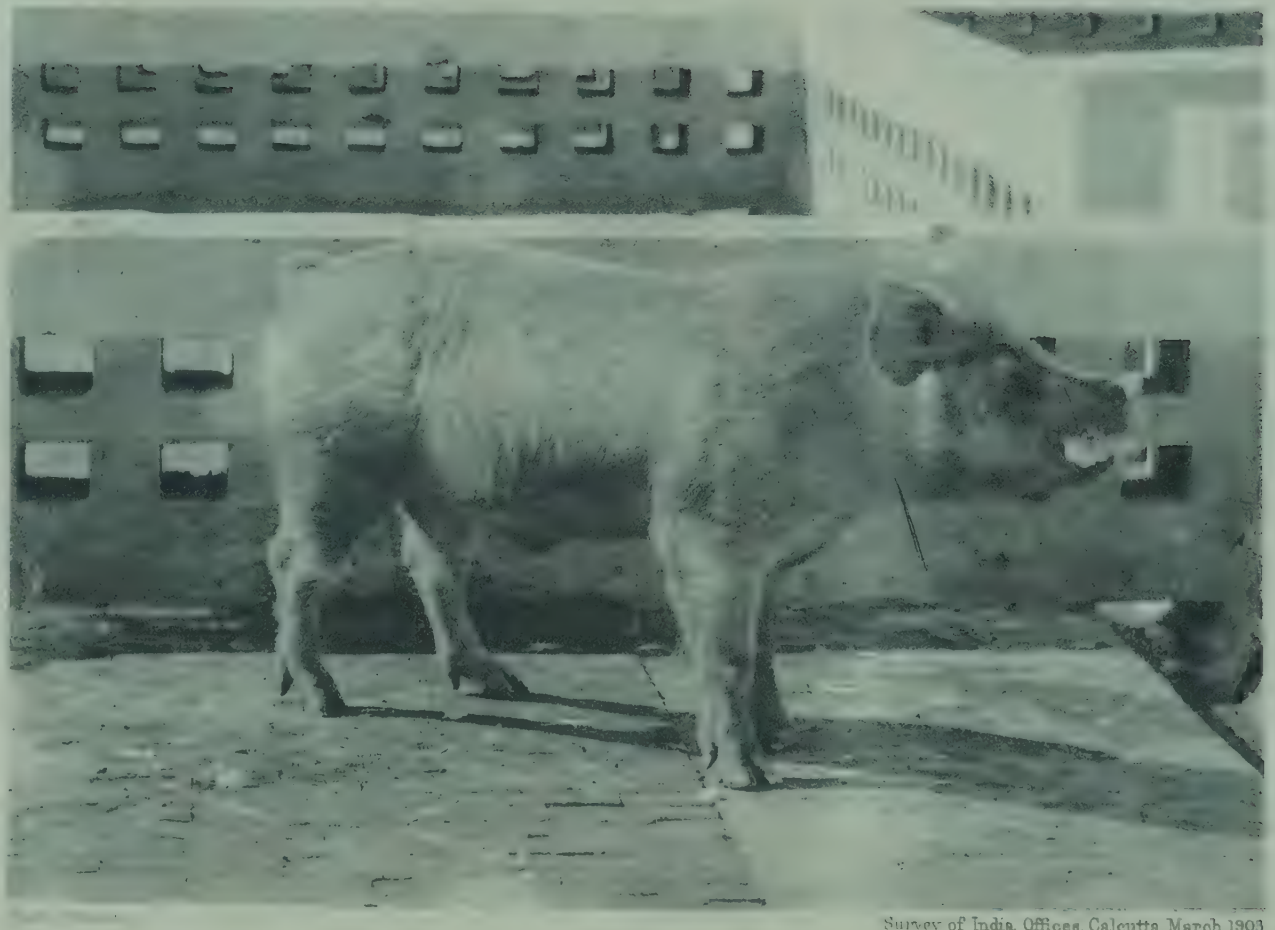
Vinegar has been found useful in imparting a delicate flavour and good colour t



Photogravure

Survey of India Offices, Calcutta, March 1905

Two cross-bred hogs, 6 months old. Sire a mid-white boar: dam a China sow. An excellent cross.



Survey of India Offices, Calcutta, March 1903

"Fraud"—a 1½-year old mid-white boar recently imported from England.

Manufacture of bacon, ham, sausages, etc.

hams, but it must be used sparingly, as otherwise it makes the meat dry and sapless. After being injected, as above described, the hams are again put in fresh pickle, with ice on top of them for 24 hours. They are then rubbed and injected again : after which they are placed in beds of salt with their shanks down-wards, so as to prevent the pickle oozing out. The same mixture of antiseptic, saltpetre and cane-sugar is freely applied to the fleshy parts ; and lastly salt is sprinkled over them. A light rubbing and pressing is applied daily for about six days. The hams are kept in salt for about 15 days, after which they are turned and stacked, rind uppermost, for four or five days to allow of all spare pickle draining off. The chief aim in curing both hams and bacon is to keep the temperature of the meat down during the first five or six days, and although this can be effected with ice, it is not so satisfactory as with refrigerating plant.

Period in salt.

Attention to temperature most important.

The hams are now thoroughly washed in lukewarm water, scrubbed with pumice stone and then washed in antiseptic diluted with cold water. All slime and salt should be carefully removed, and the hams wiped dry. They should then be hung up to dry and afterwards placed in a room, the temperature of which should be maintained at 80° Fahr. The foregoing method has been adopted after the valuable information furnished by Mr. Shaw. Of course, certain modifications in the European method have had to be made in consequence of the difference of climate.

Drying hams.

Before closing the subject of bacon and ham-curing, it will perhaps save loss and trouble in the future to others, if the authors describe some of the methods followed prior to the adoption of that explained above. The pigs were fed up to the time of slaughtering, and the carcases cut up and salted the same day, no attention being paid to the temperature of the meat. Salt and saltpetre were used *ad lib.*, and a very strong pickle, composed of saltpetre, salt, cane-sugar and mixed spices was used both for hams and bacon. These were mixed with water and boiled till the mixture became quite black. It was then cooled and placed in a tub in which the bacon was also laid. The saltpetre used was so excessive that the bacon became quite black and the flavour given to it by the spices was most objectionable. The sides and hams were thoroughly rubbed with salt, morning and evening, and a stone was often used to increase the activity of the rubbing. The meat became in consequence very hard and complaints were numerous. No pumping was ever done, as by previous failure the natives had no faith in it. The salt also was used in such large quantities that the meat was often rendered absolutely uneatable. Another pickle was made with beer with which, instead of with water, the above ingredients were mixed. The hams and bacon, however, turned out black and unsaleable. Rum was then tried instead of beer, and although the results were better, they were still very unsatisfactory. It is needless to say how heavy the loss used to be and how numerous were the complaints when the old methods were followed. Now, the bacon and hams are pronounced excellent by all customers, and indeed are preferred by many to imported produce, and except, in inclement weather, failure to cure satisfactorily is rare. When refrigerating plant is available it will be quite possible to manufacture ham and bacon equal in quality to any produced in Europe and the boon to the troops will be rendered far greater by the low rate at which the produce can be sold to them.

Advice to amateurs.

The native bacon-curers rub the meat thoroughly, morning and evening, for three or four days, and keep it constantly in a pickle made of salt, cane-sugar, saltpetre, spices and limejuice, and the meat is ready for sale in less than a week.

Bacon-curing by the native method.

Smoking, simple as it appears, requires great care. The hams and bacon, when thoroughly dry, are rubbed over with molasses or country treacle and peameal is subsequently applied. The pieces are then hung up for about three days in the smoke room, which is specially constructed for the purpose, and has a hole at the top for ventilation and perforated flues below for the fire. The stalks of sugarcane, from which the juice has been extracted, serve admirably for fuel and are quite as good as anything obtainable in Europe. The fuel is allowed to burn slowly throughout the three days and all flames are subdued by sprinkling water on the fuel. A thermometer is kept in the room, to ensure the proper temperature being maintained. When, after three days, the rind has become well coloured, the pieces are taken down and wiped with a cloth, all the peameal and treacle being removed and a little salad oil is applied

Smoking bacon and hams.

subsequently to the backs. The treacle imparts an excellent colour to the skin and the peameal prevents the outer portion of the meat being darkened by soot. Peameal is then applied to the fleshy part of the meat and the pieces are hung up till required for sale.

Pickling of heads, feet, etc.

Heads, feet and tails are prepared in pickle. They are first placed in a tub full of pickle, to draw off the blood, then injected and placed in another tub of fresh pickle, where they are allowed to remain for about a week, by which time they are ready for sale. The demand for them is so great that they have often to be sent out before being thoroughly cured.

Spiced rolled bacon.

Spiced rolled bacon is greatly appreciated by the troops; the demand is, indeed, so great that it cannot generally be met. It is made as follows:—All scraps and trimmings of fresh pork which are not required for sausage-making are put into the same kind of pickle which is used for curing hams. The skin, too, which remains after the sausage meat has been removed, is utilised. After five or six days' pickling, the pieces are removed and washed, the skins being then spread out on a table, and the other pieces spread closely over them. Small bits of fresh pork, tongues, etc., are used in filling up and a seasoning, made up as under, is sprinkled over the mass:—

Pepper	6 lbs.
Cayenne	2 oz.
Ginger	3 „
Cloves	1½ „

The quantity of seasoning to be used will depend on the quantity of the meat being prepared. The whole is then tightly rolled and tied with thin string, the ends also being carefully tied. The rolls are wrapped in cloth and boiled, after which process the cloth and string are removed, and the bacon is cut in slices for sale. The sides of poor pigs are best suited for this purpose, as a good portion of the lean meat can be used for sausages. The remainder is then put into pickle as above described, and after it has been washed and dried, long cuts are made down its entire length, and the seasoning is sprinkled over them. All cavities are filled as before with fresh pork, tongues and scraps, and the entire side is rolled and bound with string. This is a very profitable means of disposing of pork. One reason why spiced rolled bacon is so popular with the troops is that it is ready cooked.

Pickled pork.

Pickled pork should not in this country be too fat or too salt. The latter almost invariably results from the anxiety to avoid loss of meat. For every 80 lbs. of meat, allow 6½ lbs. of salt, 4 lbs. of cane-sugar (*sukkar*) and 3 oz. of saltpetre. With the exception of 5 lbs. of the salt, these ingredients should be well mixed. The pork should be well rubbed with this mixture and spread out on a table for 24 hours, when the rubbing should be repeated and the pork so packed in a vessel as to allow of the accumulation of the pickle without its soaking into the meat. While packing the meat in this way, sprinkle the remainder of the salt between the layers. The meat should remain in the vessel for about 16 days, and until the eighth day should be rubbed every other day, and then replaced in the vessel; such pickle as has accumulated being previously taken out, and poured back into the vessel over the meat. After the sixth day when pickle has accumulated, it should be similarly poured over the meat. If no pickle has accumulated, more should be made by mixing 2 lbs. of salt with 1½ oz. of saltpetre and 2 oz. of sugar, and boiling all in a quart of water. When cool, it should be poured over the meat. The meat is ready for sale after the sixteenth day, and will keep for a long time.

Fresh pork.

For fresh pork there is always a large call, to meet which pigs only moderately fat are best suited: because, as with bacon, overfat pork is not appreciated in this country. It is here that proper feeding gives the best results, more so than in any other branch of piggery products, and pigs fed on separated or skim milk always yield meat of excellent quality.

Pork sausages.

It was at first very difficult to turn out sausages of good quality. The work was done without the assistance of a proper mincer and the meat was forced into the casings in the native way with funnel and thumb, instead of by the sausage filler. At the present time, however, with Douglas's Mincers and Sausage Fillers, the sausages made cannot well be surpassed. Particular attention must be paid to the sharpening

The Mincer.

Photogravure

Survey of India Offices, Calcutta, March, 1903

"Hollywell Swell," a 2-year old Berkshire boar: sire "Lord Ormond," dam "Daisy," both imported

Photogravure

Survey of India Offices, Calcutta, March, 1903.

"Duke," a Berkshire boar, bred from imported stock. Too fat for breeding.

Manufacture of bacon, ham, sausages, etc.

of the knives used in the mincer, and to the speed at which it is worked (about 150 revolutions per minute). Two men are generally required to work it, and about 25 lbs. of meat can be conveniently minced each time. The use of this machine does not, however, absolutely preclude the admission of gristle and sinews into the sausages, and it is therefore desirable to pass the meat through an "Alexandra" mincing machine before putting it into the mincer. The "Silent" mincer is a great improvement, and it is the best in the market. Both machines can be worked either by hand or power, but a hand machine is quite enough for a military piggery.

The sausage filler works on a very simple principle, and natives soon learn to use it. The plunger is moved to and fro by a ratchet wheel propelled by a spin wheel when the handle is turned. The sausage meat is placed in the barrel, and then forced by the plunger through the nozzle. Care should be taken to see that the air-escape hole is not blocked. The casings are first soaked in a solution of salt and warm water and worked on to the nozzle. As the meat is forced out, the casing guided by the finger and thumb of the operator slips along also. It is extremely difficult, and in fact impracticable to manufacture sausages which will be equally appreciated by all customers. Two kinds should therefore be made—the one heavily spiced and the other only mildly so:—and customers can take their choice. The meat for sausages is best cut from the sides, shoulders and gammon; the fat should always be back, not leaf fat. In the first attempts made by the authors at manufacturing sausages, the kidney or leaf fat was used, and the sausages always burst when cooked, owing to the fat melting quickly away from the meat. The following seasonings have been found to give satisfaction:—

The sausage filler.

Best parts of the pig for sausages.

Mild Spiced Recipe. (1)		Full Spiced Recipe. (2)	
Lean meat	15 lbs.	Lean meat	15 lbs.
Fat	6 „	Fat	6 „
Bread	2 „	Bread, rice or sausage meal	3 „
Sausage meal	2 „	Seasoning	14 oz.
Seasoning	14 oz.	Food preservative	1 „
Food preservative	1 „		

(1) Seasoning.		(2) Seasoning.	
Salt	9 lbs.	Salt	9 lbs.
White pepper	4 „	White pepper	6 „
Ground nutmeg	6 oz.	Ground nutmeg	½ lb.
Mace	6 „	Mace	½ „
Ginger	3 „	Ginger	¼ „

Green herbs were largely used formerly, but as the majority of customers objected to the flavour, their use was discontinued. The meat, both lean and fat, is cut up by hand into lumps of 2 or 3 inches and washed. It is then put into the bowl of the machine and when about half mixed, the bread which should have previously been soaked in water and pressed, is added and, soon after, the sausage meal, and lastly the seasoning. When the bread and meal were put in at the commencement, the sausages were generally found to be too solid; it is better to add them when the mincing has been half or a little more than half completed. It frequently happens that the knives do not work freely through the mass on account of its consistency. When this occurs, about a pint of water is added to the meat while the machine is in motion. When minced, on no account should the mixture be all removed at the one time. It must be taken out gradually with a wooden spoon or large scoop. The contents are slowly reduced by removals from the inner portion, until the coarser mince is reached near the edge of the bowl. The machine is kept in motion while this is being done. If the mixture is removed all at the one time large lumps of gristle and sinews which generally accumulate near the edge of the bowl cannot be detected, and in such cases complaints from consumers are numerous. With the "Silent" mincer, these precautions are unnecessary.

Use of green herbs.

Manufacture of bacon, ham, sausages, etc.

Temperature of sausage meat lowered before filling.

The minced meat must be well ventilated or cooled before it is placed in the sausage filler, as it becomes heated by the motion of the mincer. Sausages have turned bad when this precaution was neglected. When cooled, the mixture is placed in the filler, the scoop being used for this purpose, and it is slowly passed into the casings. An enamelled dish should be placed below the nozzle of the filler to receive the sausages as they are made, and these should subsequently be linked six to the pound. Thus it will be seen that except the meat, when it is cut up prior to mincing, none of the ingredients are touched by the hand. Sausages can be made in various ways, and the liver is often minced with the meat. Many customers, however, complain if this is done, and the practice is open to objection. Livers should not be used in making pork sausages.

The following recipe makes a very good sausage :—

Lean pork	24 lbs.
Fat	8 „
Pressed bread	4 „
Sausage meal	10 oz.
Salt	10 „
Pepper	3 „
Ginger	1 „
Nutmeg	¼ „
Dried sage	¼ „

As the two kinds described on the preceding page command a good sale, and give general satisfaction, it is perhaps advisable to confine the manufacture to these only.

Hog puddings.

Hog puddings are sometimes much appreciated by the troops. The following recipe answers very well :—

Lean pork	16 lbs.
Fat pork	6 „
Sausage meal	2 „
Bread	3 „
Cornflour	1 lb.
Seasoning as below—	12 oz.

Salt	9 oz.
White pepper	5 „
Cayenne	1 „
Mace	¼ „
Ground thyme	1 tablespoonful.
Nutmeg	¼ oz.
Cloves	¼ „

The meat is cut up finely and passed with the seasoning through the Alexandra mincer, a pint of water and six eggs being added. The mixture is then removed to the sausage filler by which it is forced into wide pigs' casing, and then allowed to simmer for half an hour in water of a temperature of 180° Fahr. They are then plunged into cold water and kept there till quite cool, when they are removed and hung up to dry.

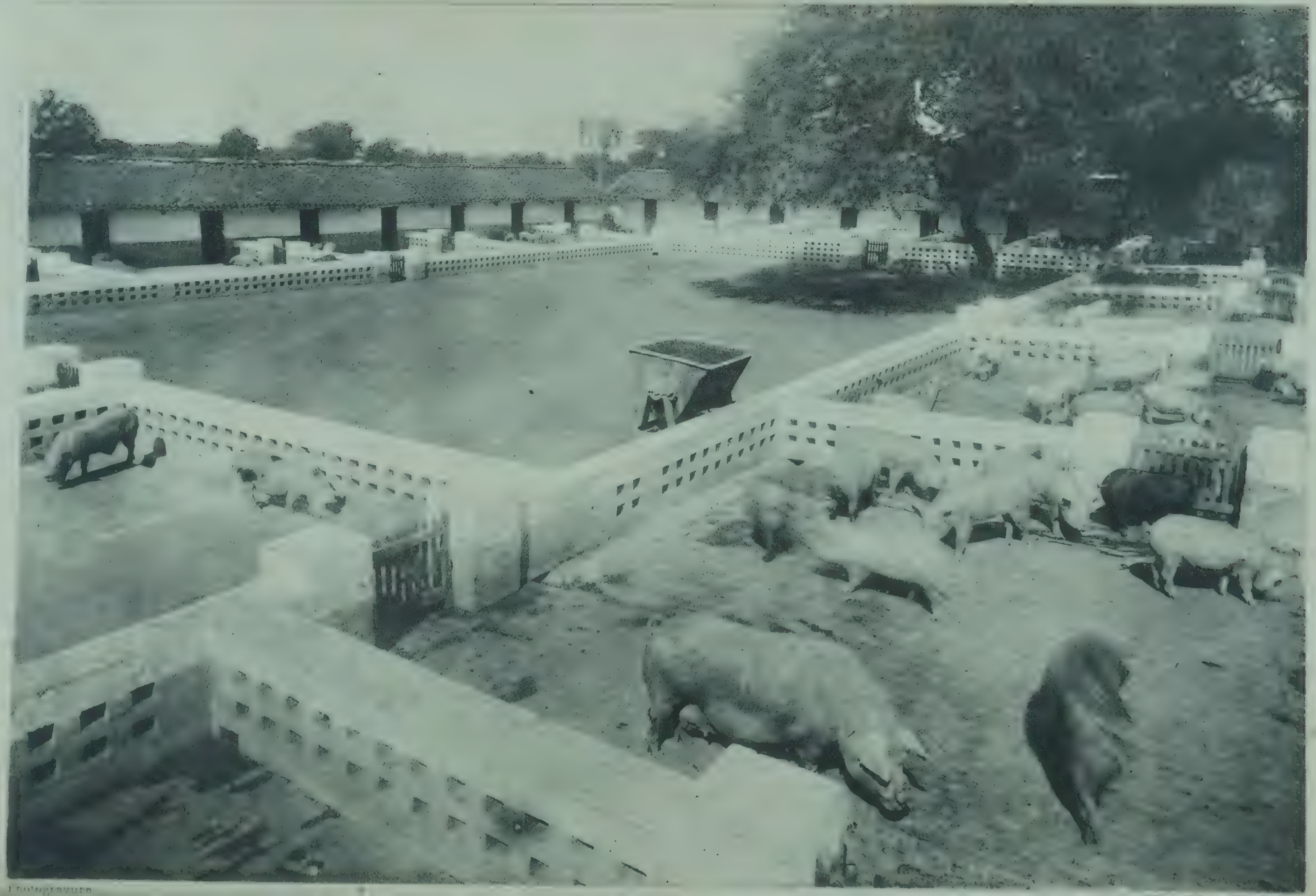
Black puddings.

For black puddings, to every 84 lbs. of meat, add 140 lbs of blood. The meat and fat, after being cut into small cubes, are first partially boiled and the blood and other ingredients are mixed with 2 oz. turmeric. All is then placed in the sausage filler, and filled into big guts or bullock's runners. The latter will be objected to on religious grounds if *khatiks* are employed in the manufacturing room. To prevent the blood coagulating, it should be stirred gently as it is drawn from the pig, and a little warm water with 2 oz. salt and 2 oz. preservative added for every gallon of blood. The puddings are tied in lengths of 18 inches, both ends being joined so as to form a circle, and are then boiled gently for half an hour at a temperature of 180° Fahr. When

Photogravure.

Survey of India Offices, Calcutta, March, 1903.

Store pigs, from 1 to 2 months old.



Manufacture of bacon, ham, sausages, etc.

cooked, they are removed from the copper and dried, and, before being presented for sale, are gently rubbed over with salad oil. The following is a good recipe:—

Lean meat and trimmings		72 lbs.
Fat		12 „
Blood		140 „
Barley (boiled in a bag)		40 „
Onions, raw and chopped finely		3 „
Seasoning as below—*		4 „ 6 oz.
* Salt		6 „
Pepper		5 „
Coriander seed		¼ lb.
Cloves		2 oz.
Cinnamon		2 „
Nutmeg		2 „

The sale of black puddings is not always permitted by the medical authorities in India, and they should therefore only be made to order.

Savoury ducks are spiced balls wrapped and fried in pieces of the caul. To make them, take— Savoury ducks.

16 lbs. scrap meat (pork, etc.),
5 „ stale bread (ground) or sausage meal,
3 oz. preservative, and
½ lb. chopped onions.

Add 12 oz. of a seasoning made of ½ lb. of pepper, ¾ lb. salt, 1 oz. of rubbed sage, and 1 oz. thyme. The brains, hearts and livers are generally cut into slices and wrapped in pieces of the caul and each ball or piece is sold for one anna.

There is not a regular demand for brawn in India, but it can be easily made to order. After the head has been thoroughly cleaned, and all the bones, the tongue and eyes removed, rub the flesh with a mixture of 5 lbs. salt, ¼ lb. saltpetre, and ½ lb. dry antiseptic: the same treatment being applied to the tongue. Then place the whole in a tub, the tongues below, and the cheeks above, one over the other, rind to rind,—sprinkling the mixture well over each layer. The meat should be thoroughly covered with the pickle and kept in it for about 36 hours, when it should be removed and boiled in sufficient water to cover it. It should be boiled for about an hour at a temperature of 212° Fahr. It is then taken out of the water and placed on a sieve, and the jelly strained out of it. It is now cut up into small squares, and placed in moulds into which the jelly previously strained has been poured. The mass is then allowed to settle and cool. The following seasoning is added while the meat is being boiled:— For every five heads, half an ounce of white pepper, two drachms of cayenne, and a few whole cloves and pepper-corns. Brawn

For this, select a perfect head with good ears and cut the head off well up to the shoulder, two or three joints of the neck bone being left attached to it. Then remove all the bones and wash thoroughly in cold water to get rid of the blood. When clean, place the head in pickle for five or six days. Then wash it and fill with sausage meat: stitching on a piece of skin at the back of the head and the sides of the mouth so as to retain the stuffing. Then roll in cloth, and boil gently. When sufficiently boiled, remove it from the pot, and allow it to cool before sale. Boar's head, (glazed).

Scald the head till the skin can be removed easily without cutting. Then separate the bones and lay them, with the meat, in pickle for four days, some tongues and pieces of pork being placed in the same pickling tub. The meat should then be removed and boiled until it comes easily away from the bones. The meat and tongues are next cut into small cubes and seasoned with the mixture used in sausage making, with the addition of a few eggs, and some pepper-corns. The skin of the neck and sides of the mouth are then sewn up, an aperture being left for the nozzle of the sausage machine. Fill with the pickled pork (which should first be finely minced) and then sew up the aperture. Wrap in a cloth and boil for an hour and a half. Head (galantine).

Manufacture of bacon, ham, sausages, etc.

During the boiling, the ears should be kept above water, and when cooked, it should be cooled and the cloth removed. The head can be sold either whole or in cut. Boars' heads, prepared in either of these ways, are readily purchased by the troops : but if care is not taken in pickling the heads, the meat is likely to become over-salted. The addition of fat cut into small cubes, and some sausage meat is an improvement.

Pork pies.

Pork pies probably command a better sale than any other article of piggery produce, and it is astonishing what good prices the troops are prepared to pay for them. They can be carried in the men's haversacks during manœuvres. This part of the bacon factory requires special attention to details and cleanliness. Pork pies should be made without any of the ingredients being touched by the hand, and this is possible with the modern machinery specially invented for this purpose. For the manufacture of pork pies, the following machines are necessary : an Alexandra mincer, a paste roller, a pie moulding machine, and a pie baking oven. These are not only very simple in use but very valuable, and can be obtained from Messrs. Douglas & Son's, Baltic Wharf, Putney, London. The Alexandra mincer can be regulated to cut meat into cubes of any size. A stock of various sizes of tin pie-moulds is also necessary.

The meat, both fat and lean, is cut into cubes of about two inches, but should not be crushed or bruised. It is then passed through the mincer. If too finely minced, it will settle down into a solid and sodden mass in the crust, admitting very little stock, and that only on the top. It should be minced, therefore, to allow of the jelly penetrating it freely. The pastry is made with the roller, and with a paste-cutter is cut to the requisite size for the moulds. The pastry is placed on the mould, and the pie-making machine gently presses it to the bottom and against the inner side of the mould. A little surplus pastry is left projecting over the edge of the moulds, and should not be cut off—the machine itself pressing it off when the meat has been filled in and the top crust pressed down. Care should be taken to fill the meat in the moulds very lightly and without any pressure. With the smaller cutter, the pastry for the top of the pies is now cut and placed in position, the machine pressing it down and removing all spare pastry. The pies are now ready for the oven, and the moulds are arranged on trays which are placed in it. The baking should be done gradually. When finished, the pies are taken out and allowed to cool in the open air, if possible. At this stage, a glazing of egg-flip is applied to the top of the pies, a puncture being made in them to admit of the jelly being put in. This is done with a funnel, but many errors are made in the process. Sometimes the stock is too thin, in which case it saturates the pastry and detracts from the appearance of the pie. The pastry is occasionally made too thick, and customers complain of getting more pastry than meat. Every effort should therefore be made to have it of the proper thickness. If the native establishment are not carefully supervised, they will not boil the stock long enough to ensure its being good. They are keen to use gelatine in preference to stock, but gelatine does not give as nice a flavour. For the stock, the bones and parings should be boiled for about four hours. When removed from the fire, it should be strained through a clean muslin and the seasoning added in the proportion of half an ounce, with an ounce of preservative, to each gallon of stock. The seasoning is made of equal quantities of salt and white pepper.

The pastry.

The pastry is undoubtedly the most difficult part of pie-making, and no two persons can perhaps make it exactly alike. Take the Melton Mowbray pies which are famous all the world over : it is the pastry which makes them so much appreciated : and one of the authors, when in England, endeavoured to get a leading pork butcher in Leicester to teach him how to make this pastry, but the butcher declined, although the request was coupled with the promise of a large fee. The following is a recipe for pastry :—

6 lbs. flour.
3 „ boiling lard.
2 oz. baking powder.
1 „ corn flour.
2 „ salt.

Mix together with about a small cup of water.

Pork pies are made of various sizes, but the two-penny and four-penny pies are those which sell best.

Sausage rolls also command a good sale among the troops by whom they are much appreciated. The pork sausages are first half baked in the oven, and then removed and covered with the pastry. They are then replaced in the tray and returned to the oven. When cooked, the rolls are taken out, well smeared with egg-flip, and allowed to cool. Sausage rolls.

The manufacture of lard is a somewhat difficult matter, and without the use of proper machinery it is impossible to secure good colour and grain. The fat for lard-making is obtained from the leaf and kidney fat, the fat of the neck and intestines and from the caul. Some persons simply wash and cut the fat into small pieces, and put it with bay leaves and cloves into a copper vessel to melt down over a good fire, the lard being removed as the fat melts. Lard so made is generally kept separately as it is discoloured. Others, before melting, either grind or mince the fat finely into a copper vessel or a steam double-jacketted vessel. This method produces excellent lard of a good white colour. Others, again, grind the fat thoroughly and boil it in water, adding a little carbonate of soda when boiling, to remove all dirt. The best quality of lard is that which is obtained from the ham fat, and it should be made and kept separately from that obtained from the intestines and other parts of the pig. While boiling or cooling, the lard should be frequently stirred. The bladders should be turned inside out before being filled. The quantity of lard obtained from the country pig is twice as much as that from imported stock and as much as 35 lbs. of lard have been obtained from a single country pig. Manufacturing lard.

Very little income is realised from the bristles (or, properly speaking, hairs) of imported stock, while as much as Re. 1-8-0 have been realised for the bristles of a country pig. The bristles of an imported pig bring in from two to four annas only.

Ample information has been furnished in the foregoing pages to enable farm managers to conduct small military bacon manufacturing concerns with success, and though numerous recipes for the manufacture of various other articles might have been given, it has not been considered expedient to include them. To manufacture well all that has been recommended, will fully occupy the time of even the most capable manager. Practical experience will soon teach that it is wiser to do a little well than to do a great deal badly. The authors feel sure that, with the aid of the hints given in this manual, managers of farms will, with a little practical experience, be able to introduce many desirable improvements into this, the most valuable branch of military farms.

CHAPTER IV.

Diseases of the Pig.

Before closing this branch of their work, it will prehaps be helpful if the authors describe a few of the diseases most common among pigs in India, and the treatment which should be adopted. Diseases of the pig.

The pig, unlike other animals, is very difficult to treat when out of health, as unless it is thrown, it is often impossible to administer any medicine. The easiest way is to give all medicine mixed with the feed, but, when sick, pigs sometimes refuse to eat. The natives generally throw pigs to administer medicine, which is poured down the animal's throat through a hollow bamboo—called a "donga."

The diseases from which pigs mostly suffer arise from the digestive organs or are connected with the skin. Good grazing, wholesome feeding and perfect sanitation in the housing of the pigs will minimise the risk of epidemics and tend greatly to keep them in good condition. Constant and rigid attention to these points will certainly save serious loss and anxiety. The old idea of allowing pigs to wallow and live in a dirty state so as to fatten them quickly has been completely exploded, and scrupulous cleanliness is now insisted upon as essential both in the styes and yards. A perfect system of flushing and drainage should therefore be provided in all piggeries. When a pig really gives in to sickness and refuses his food, he must be really bad, for pigs are hardy animals and do not give in until actually prostrated.

Every case of cough should be treated as serious : if at all neglected, it will certainly Cough.

lead to complications and the affected pig will succumb. Some pig-farmers are inclined to altogether ignore this complaint, or regard it with but little attention until their pigs begin to die off. In some cases, the cough is not attended with heaving at the flanks, commonly called "rising of the lights." The complaint in such cases is only in a mild form, but, if neglected, it will probably assume a more serious one. When an animal exhibits the heaving at the flanks, it should at once be segregated, as cough in this form is in all probability contagious. Segregation of pigs suffering in this way was formerly never practised and the death-rate used to be very high; but with the immediate isolation of sick pigs, deaths are now of infrequent occurrence—a fact which points to the complaint being contagious. It chiefly attacks young pigs before and after weaning. If it does so before they are weaned they seldom recover, and those which do survive the attack are so reduced in condition that it costs more than their value to restore them to their former condition. The symptoms are—loss of appetite, distressing cough with heaving of the flanks, dullness and a staring coat.

Treatment. Bleed at once, from an incision in the palate a little away from the teeth, and give a purgative. A strong one is often necessary as there is obstinate constipation. The dose is an ounce of Epsom salts with an ounce of sulphur for a full grown pig. After this, give two grains of *digitalis* mixed with six grains of powdered antimony and half drachm of *nitre*. Old *ghur* and ginger should also be given twice a day until the animal recovers. The affected animals ought to be kept clean and warm, and should get bran mashes or light diet only.

Inflammation of the lungs. Inflammation of the lungs is very common amongst pigs and generally ends fatally. Only one instance of recovery from this disease has been known at Allahabad since the piggery started, and that was of a pig which was never fit for anything afterwards. The mortality may probably have been due to inability to diagnose the disease correctly and promptly, and, in most of the cases, the proper treatment was only commenced when the animals were nearly dead. The pig suffers intense agony in lung disease and swine fever. The symptoms are shivering, loss of appetite, laboured breathing and a very severe cough. All affected animals should be kept warm, and dry bedding should be given them. The food should be light and nutritious. Give them each two drachms of saltpetre and old *ghur* and milk mixed with ginger to drink.

Diarrhœa or scour. Diarrhœa (or scour) is a troublesome and frequent complaint, which attacks young pigs more commonly than full grown ones, and is often fatal. There is no fear of mistaking it, as the evacuations are many and generally white. It is brought on by cold and damp housing, irregular feeding or a sudden change of the mother's diet. Young pigs have often been known to suffer from this disease when their mothers have been fed on rank vegetables, lettuces chiefly, or heating grains, the mothers being similarly affected. As the loss of young pigs from this disease is always very heavy and it seems to spread rapidly, it is always treated as a contagious one and affected animals are isolated. For very young pigs, the treatment is best effected through the mother's milk. A tea spoonful of the following mixture given every other morning for about eight days, will afford relief :—

Chlorate of potash	4 oz.
Milk of sulphur	8 „
Gentian	8 „
Copperas	8 „

These ingredients should be well-powdered and mixed.

Constipation. Constipation can always be guarded against by careful attention to the diet. When pigs are found to be constipated, slops or laxative food should be given, or vegetables or other green food. There is a common inclination to regard constipation in all animals with considerable indifference: but a greater mistake can hardly be made, as constipation is generally the forerunner of nearly all complaints. Continued constipation is a sure sign of something wrong in the swine-yard. Sows after parturition, and well-fed young pigs are frequent sufferers.

Treatment. Give a purgative, either sulphate of soda mixed with the separated milk, or an ounce of Epsom salts, and an injection of soap and warm water.

Diseases of the pig.

Loss of tail. Loss of tail is very common with young pigs which have not been weaned, but if treated in time, it is prevented from spreading. It must be contagious, and is in some cases more severe than in others. By degrees, the tail drops off entirely.

Treatment. Keep the styes and the young pigs perfectly clean, applying carbolic ointment, a strong solution of nitre, or a solution of phenyle to the red spots as soon as they appear. Dipping the tails in a mixture of equal parts of mustard and *senwa* oil, and an ounce of sulphur has proved effectual. It was first popularly believed that the sows caused the complaint by standing on the tails of their young, and inexperienced native keepers of swine to the present day hold this opinion.

Mange. Pigs frequently suffer from mange and it seems to be peculiarly contagious. The animals when first attacked are constantly scratching themselves; then a few red spots appear on the skin, and by degrees spread over the body. The disease seems to generate spontaneously, but some assert that it is caused by an insect burrowing into the skin, the germs of which enter the skin when the pig begins scratching itself. It seriously affects the condition and growth of young pigs, and causes the older ones to fall off. If treated in time, much loss and trouble will be saved as it spreads very quickly, especially when all the pigs are washed in the same water.

Treatment. Cover the whole of the body with a lather of soft soap, which should be washed off three or four hours afterwards with warm water. Scrub the affected pigs with a brush and wash them with a decoction of tobacco and water, one part of the former to fifteen parts of the latter. Repeat the process for two or three days and then apply the following ointment: 1½ pint turpentine, 1½ lb. lard, 1 lb. *senwa* oil, ½ lb. powdered sulphur, melted together and mixed with 2 ounces of mercurial ointment.

Worms. The witnessing of post-mortems and the killing of many cattle and pigs enables one to see how much more liable the pig is to intestinal parasites than are cattle. This perhaps is due to all manner of garbage being eaten by it. The animals which suffer from worms, although having ravenous appetites, are always in poor condition. In all such cases treat for worms. Some of the worms found in the pig are round and of a reddish colour, about an eighth of an inch thick, and six or seven inches long: others are white, flat, and long. Pigs affected by worms are always rubbing themselves especially in the rear parts, owing to the itchiness. They often rub until the skin is laid bare and the animal is treated for mange instead of for worms.

Treatment. Give half a tea-spoonful of santonine, morning and evening, for two or three days and follow each dose immediately with a brisk purgative. Another remedy is a tea-spoonful of Barbadoes aloes with a tea-spoonful and a half of copperas given every morning for four or five days. Ground *neem* leaves mixed with a little salt are also good.

Kidney worms. Boars are frequently troubled with these worms, and although the complaint is not always fatal, none of the pigs which have been attacked by it on the Allahabad farm ever recovered. The animal appears to lose the use of its hind quarters, and from the very outset seems almost unable to walk, with a constant inclination to lie down, from which position he finds it difficult to rise. When he moves, he drags his hind legs along the ground, as if the hind quarters were entirely paralysed. He soon becomes unable to move at all. In some cases, animals have been known to linger for as long as three months, before succumbing. The worms infest the leaf-lard in the neighbourhood of the kidneys, and burrow along through the fat, weakening the loins of the pig, and setting up inflammation of the kidney.

Treatment. Turpentine isgenerally the best treatment, a table-spoonful at a time being administered internally and some rubbed over the loins. Fomentation of the loins is also efficacious. With the evening feed, give three tea-spoonsful of a mixture composed of equal parts of sulphur, camphor, pepper and copperas.

Lice. When pigs are neglected or proper attention is not paid to their cleanliness, they suffer terribly from lice which attack even sucking pigs and thus often retard their growth. The constant irritation from this cause, prevents thriving in young and old pigs alike. If precautions are not at once taken against them, it becomes very difficult to remove the lice afterwards, as they get into the crevices of the pigstyes, etc.

Treatment. Apply a mixture composed of two parts of kerosine oil and one of lard to the hair and skin of the animal. Two or three applications are ordinarily sufficient if care is

taken to apply it well where the nits are most abundant, generally behind the ears and at the flanks. In milder cases a strong solution of phenyle has proved effectual.

Paralysis.

Paralysis frequently attacks pigs and with such severity that it nearly always ends fatally. It generally originates from a strain or blow on the back and occasionally from exposure. The natives have a superstitious idea that it is due to some bird of evil omen having perched itself on the animal's loins.

Treatment.

Rub the loins well with a liniment made up of equal parts of turpentine, olive oil and cantharides. Fomentations with a blanket well soaked in very hot water and wrapped round the animal's hind quarters are also effectual; or the loins may be rubbed with mustard oil, salt and gherú. Animals affected with paralysis should be kept in a perfectly dry and warm place, and given a laxative diet, and their bowels must be kept well open.

Blind staggers.

The disease known as blind staggers breaks out very suddenly and unless promptly treated, ends fatally. The symptoms are a loss of appetite with a stupid, dull, appearance—the animal showing no inclination to move. Its eyes are inflamed, its pulse quick, and there is constipation. After some time the pig becomes excited, turns round and round wildly, as if blind, and finally falls down and dies.

Treatment.

Dash cold water over the animal and administer a brisk purgative made up of 1½ oz. Epsom salts, 3 drachms ginger, 4 drachms gentian, and 10 grains calomel. In addition to this, give an enema of soap and warm water every half hour. Make a small incision in the skin above the eyes, and rub in salt and pepper as a counter-irritant. As soon as the bowels are opened, the animal is at once relieved. Although the disease seems to make its appearance suddenly, it has in most cases really been developing for days unobserved, during which time the animal has been suffering from severe constipation.

Swine fever or cholera.

Swine fever (or cholera) is without doubt the greatest scourge among pigs. Its period of incubation may be either short or long, but from the cases which have come under their own observation, the authors are satisfied that it makes its appearance suddenly, the period of incubation never extending beyond two or three days. The animals, it is true, may have been suffering for some time before they were observed to be sick. The disease, however, is one well known to the native pig-farmer in India, and in some cases, the attack has been known to come on quite as suddenly as anthrax among cattle. Every precaution should therefore be taken to guard against the ingress of so terrible a disease among swine, as no sovereign remedy has yet been discovered, although all manner of treatment has been tried. The natives of India no longer attempt to combat it, and the moment an animal is affected, it is removed and killed. The carcases of animals dying from the disease should be burnt and not buried as it is extremely contagious. On this account, animals attacked with it should be forthwith isolated and strong disinfectants freely used in the styes and exercise yard. It is also advisable, while the disease lasts, to fumigate the piggery, morning and evening, by burning litter and sulphur in it.

Symptoms.

There is, at first, fever with shivering and great lassitude. Weakness is most pronounced in the hind quarters and the pig lies mostly prone on its stomach. As the disease develops, the weakness extends to the fore-quarters and the neck, the snout becomes dry, the appetite disappears, and is replaced by intense thirst and inclination to lie in water. Towards the end, red spots appear on the skin, the cough becomes increasingly severe, and very heavy breathing is accompanied with heaving at the flanks. In this disease, the lungs appear to be most seriously affected.

Measles.

Although not frequently fatal, measles is also a troublesome complaint among pigs, and is dreaded by pig-farmers. The disease appears almost every year among pigs which are developing and fattening. It is exceedingly difficult, until an animal has been killed, to tell whether it has suffered from measles, but, when killed, the cysts will be found about the size of barley corns all over the carcase, under the skin, in the muscles, in the eyes, under the tongue, and all over the meat. The native name for this disease is "damal." These bladder worms, or cysts, are said to be miniature forms of the tape-worm, and are ascribed to pigs feeding on human and animal excreta in which the germs exist. Although, perhaps, it is not absolutely

dangerous for Europeans to eat bacon made out of such meat, if properly cooked, it is undoubtedly risky, and meat of this description should be given to the natives. If the cysts are scattered throughout the body, there is no remedy for the disease. When it is detected in its early stages, brisk purgatives and a laxative diet may prevent its spreading.

Small-pox in pigs very much resembles the same disease in cattle. It is extremely contagious, and, if not diagnosed in time, will soon spread through the herd. It reduces the pig's condition very considerably, but is seldom fatal. Red spots, of varying sizes, cover the whole body, and burst as they develop. Small-pox.

Administer purgatives and keep the bowels well open, giving a laxative diet. Segregate all affected animals. Lard should be rubbed over the body, when the sores burst. The native *khatik* is inclined to regard this disease with indifference, and is not always keen on isolating infected animals. Treatment.

Wounds and abscesses denote a morbid state in the pig, and are generally due to bad food, unclean and unhealthy pigstyes, and also to injuries inflicted by the animals upon each other. It is very difficult to apply poultices to wounds or abscesses in a pig, and other methods must therefore be resorted to. All abscesses should be opened, washed and treated with carbolised oil, or other similar unguent of recognised efficacy. Wax ointment made up as follows has always proved efficacious: *Recipe*—Equal parts of wax, cocoanut oil, lard and vaseline, to which a small quantity of sulphate of copper should be added. Wounds and abscesses.

The diseases treated of above are those which have chiefly come under the notice of the authors, and they trust that this short account of their symptoms and treatment will be found useful by all farm managers.

LIST OF MEDICINES, DRUGS, ETC.

Aloes.—A purgative when used in solution with linseed oil, the dose is 2 ounces for a full grown pig.

Antimony.—Seldom given alone. With sulphur, it has a cooling and cleansing effect, when given internally. With sulphur and lard, it forms a good ointment for mange.

Arsenic.—Useful in mange and other skin diseases. From 1 to 1½ oz. dissolved in a gallon of water is a sufficiently strong solution.

Calomel.—As this is dangerous, it should be carefully used.

Carbolic acid.—A powerful antiseptic, should always be diluted in the proportion of 1 to 50 or 60.

Carbolised oil.—Antiseptic, and emollient for wounds. Add 1 pint of carbolic acid to 8 pints of gallipoli oil.

Caustic.—See Nitrate of silver.

Chalk.—Important in checking diarrhœa.

Charcoal.—Extremely useful in promoting digestion and restoring tone to the system.

Creosote.—Useful in virulent cutaneous eruptions.

Croton oil.—A powerful purgative only used in cases of obstinate constipation. Dose from 1 to 3 drops.

Digitalis.—A valuable sedative in fever cases.

Epsom salt.—An effective purgative in most of the ordinary ailments of cattle. The dose is from 1 to 2½ oz. with ginger and *ghur* added.

Gentian.—An excellent stomachic: it should be given in combination with every aperient.

Ghi.—Is a good purgative and cooling. In obstinate cases of constipation, as much as 4 lbs. have been administered to a cow, without effect.

Diseases of the pig.

Ghur (old), or treacle.—These are cathartics and are invaluable among horned cattle. In obstinate cases of constipation, 4 lbs. given daily in liquid form for three days will have the desired effect.

Ginger.—An excellent stomachic and tonic. Dose from 2 to 3 chittacks, with Gentian added.

Linseed oil.—Occasionally administered as a purgative in doses of from 10 to 20 oz.

Mercurial ointment.—In combination with sulphur ointment, is used for mange scabs: one part of the former to eight parts of the latter.

Nitrate of silver.—For old sores when cautery is needed.

Nitre.—An excellent cooling medicine, in cases where there is a tendency to fever.

Palm oil.—Useful as an application in cases of cutaneous eruptions.

Phul Sharàb (*Arak*).—Useful for colic. A pint or quart, according to severity.

Salicylic acid.—Of great use in foot and mouth disease. Generally useful as an antiseptic. Dose a teaspoonful mixed in water.

Salt.—Purifies the blood and keeps animals in good condition. It should always be given with the food.

Soft soap.—Always very useful.

Sulphur.—Cooling and mildly aperient: in ordinary use for that purpose. It is also used in the preparation of mange ointment (see antimony).

Tar.—Is useful for external application to the feet or wounds and also in cases of foot and mouth disease.

Tobacco.—Used in mange, cutaneous eruptions, and for lice.

Turpentine.—Used to destroy worms.

Vinegar.—Used in cases requiring cooling fomentations.

INDEX.

PART I.

Part II.

G. I. C. P. O.—No. 16740 D. F., B. C.—27-11-1903.—500.